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Christianity in a world of
science

CHRISTIANITY IN A WORLD OF SCIENCE

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BY

CHESTER FORRESTER DUNHAM

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1930

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TO MY WIFE

PREFACE

Christianity lives to-day in a world of science. It is a perpetually changing and growing world; one which is being constantly explored and in which there is ceaseless adjustment to manifold discoveries of truth.

Such a world of science profoundly affects Christianity. It challenges a limited world view, a double standard of truth, interference in the process of the ages, and disunity in the universe.

Christianity must make a scientific adjustment if it is to live in harmony with the new age. The attitudes and methods of the past will not work to-day. Ecclesiastical isolation becomes impossible. Inquisitional warfare is futile. Legislative control is a step backward. Symbolic compromise is mere temporizing. A whole-hearted coöperation of Christianity and science is required to meet adequately the needs of this new day and age.

The purpose of this book is to trace the relation between science and Christianity, beginning with Hebrew and pre-Hebrew backgrounds; to reveal what science has contributed to Christianity; and to suggest the vital coöperative service that both may render as partners in the building of the civilization of to-morrow.

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CHRISTIANITY IN A WORLD OF SCIENCE

CHRISTIANITY IN A WORLD OF SCIENCE

CHAPTER I

THE WORLD OF ANCIENT SCIENCE

Self-preservation drove ancient man to understand and control nature. The world appeared to be one colossal conspiracy against his happiness and welfare. The smoking mountain covered his vineyards with ashes and lava. Plagues of insects devoured his crops. Wild beasts pounced upon his domesticated animals. The tornado seared a pathway of desolation across his property. An earthquake shook the earth to its very foundations. Unfriendly neighbors and hostile tribes raised their hands against him. Burning fever attacked his children. Death silenced a member of his family. The enemies of man seemed to be legion. They were lurking to attack him on every occasion. In this fearful world man craved security and protection. He must understand and control nature or perish.

Ancient man cherished a firm conviction in a living universe. Spirits inhabited the heavenly bodies, the objects of earth, and the movements and activities of nature. These unseen powers might be helpful or harmful or neutral. If their conduct was beneficial man deemed them good spirits, and if harmful, bad spirits or demons. This conduct was always the direct and intentional expression of the likes or dislikes of the spirits. Therefore man must reckon at all times with the spirits which resided in the sun, moon, stars, wind, lightning, trees, hills, stones, and in sickness. His chief task was to gain the favor of the good spirits and avoid the ill will of the bad spirits.

To master and control the spirits the method of force was tried. Man overpowered the spirit, made it his slave, and commanded it to do his will. He imprisoned the spirit within himself, dictating its activities according to his wishes. He also had the power of thrusting spirits into other persons and of casting them out. He was further able to confine a spirit in a portable article, such as a charm or amulet, thereupon directing its powers along desired courses of action. If he possessed an object that had once belonged to a person he could still influence that individual, since contacts once formed were operative no matter how far distant the person might be. This jailer of spirits exerted a tremendous authority over his fellow men. He was considered a rain maker, a healer of diseases, and a foreteller of the future.

The method of entreaty was employed to please and persuade the spirits. Humble petitions were accompanied by expressions of gratitude and praise and by valuable gifts, designed as aids to win the favor of the spirit. In the process of the ages growing needs projected growing spirits, and the outstanding needs of mankind placed some of the spirits in a supreme position of importance, with the new rank of deity. The impersonal spirits of nature were becoming personified and superhumanized. The whims of the individual were being transformed into the social desires of the tribe. A covenant of obedience and loyalty was established between a certain deity or group of deities and the social group. This relationship endeavored to answer two all important questions: What does deity require of man, and what does man expect of deity? The method of entreaty was based upon the worship of nature in the effort to achieve self-preservation in both the personal and the social relationships of life.

The method of observation was utilized to discover and understand the ways of the spirits. Fear and wonder were ever accompanied by curiosity. There arose an impelling desire to explain the ordinary events of existence such as sickness and health, day and night, heat and cold, life and death; to interpret such extraordinary episodes of life as earthquakes, floods, volcanoes, comets, lightning, eclipses, cyclones and plagues; to find an explanation of the origin of the world, of plants, animals, mankind, races, languages, institutions, evil and suffering; and to devise ways and means of mastering the environment in which man found himself. And it was these desires which gave rise to the simple beginnings of science.

The ways of the spirits were observed by a study of the stars. The sun appeared to be nearer the earth at certain times and these times occurred with striking regularity. The hot and cold, rainy and dry, seasons likewise appeared in systematic succession at regular intervals. The ways of the moon were studied and also the tides of the ocean. Eclipses of the sun and moon were so carefully studied that accurate predictions were made. These observations became incorporated in tribal tradition, and were handed down orally from generation to generation. A more accurate and permanent record was desired, and writing arose, first through letters and numbers. The human body was the first standard for primitive mathematics, counting being accomplished on the fingers and toes, and measuring by means of the span of the hand, the length of the foot and the pace. Later came the standardized pieces of wood or metal to serve as counters. The practical needs of man in daily quest for food, clothing, shelter, and protection gave rise to simple though valuable inventions; the forked stick, the wheel, weapons, pottery, the uses of fire and light, and the calendar.

> In a rude way he is a physicist in making fire, a chemist in cooking, a surgeon in binding up wounds, a geographer in knowing his rivers and mountains, a mathematician in counting on his fingers. All this is knowledge and it was on these foundations that science proper began to be built up, when the art of writing had come in and society had entered on the civilized stage. . . . And it has been especially through counting and measuring that scientific methods have come into use.[1]

These three methods of force, of entreaty and of observation were not sharply differentiated by man in his supreme task of understanding and controlling nature. He still believed that the phenomena of nature, celestial and terrestrial, were dominated by spirits and deities, who expressed their wishes in impetuous fashion, and who must be won in other ways than by mere observation. The primitive scientist was also a magician and a priest. In the study of the stars the astronomer was also an astrologer and a member of the priestly class. In the realm of medicine the physician was likewise a member of the religious order and an exorcist. The spirits which controlled the stars or caused disease were equally the concern of religion, magic and science, with the common motive that of self-preservation, first revealed in individualistic and later in social, tribal, expression.

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[1] E. B. Tylor, *Anthropology*, pp. 309-310.

But these first observations of stars and earth, these primitive instruments of counting, measurement and writing, and these simple mechanical inventions, were slowly but surely bringing certainty, security and protection into the world of man. There was no conception of the uniform laws of nature, no idea of universal cause and effect and no belief in process as distinct from spirits. There was no theoretical study of scientific truth for truth's sake, that laws might be discovered. The practical needs and affairs of daily living had given rise to a rather crude experimental method which resulted in a body of knowledge that was incomplete, unorganized. Yet this knowledge afforded a limited scientific control of the world of nature. Childish interpretations of nature, based on sense impressions and appearances, were slowly being undermined by the method of observation and experimentation. Science began its age-long task of coping with myth, magic, mystery and superstition.

Babylonia is one of the birthplaces of ancient science. From early times the priests systematically observed the heavenly bodies and recorded the results of their observations on clay tablets. Every large city in the land had its temple, its *ziggurat* or temple astronomical observatory, and a library of astrological books. There was also a School of the Heavenly Science in affiliation with the temple observatory, with a complete curriculum devoted to this important study.

These priestly scientists undertook the making of the first maps of the universe. They listed twelve groups of stars which to-day are called the Signs of the Zodiac. The special objects of study were the five planets: Venus, Mercury, Mars, Saturn and Jupiter. Eclipses of the moon were foretold, and were known to be caused by the shadow of the earth cast upon the moon. Hand in hand with the discoveries in the realm of physical science went achievements in mathematics. For the measurement of land geometry increasingly played an important rôle. In the determination of a calendar a year of three hundred and sixty days, twelve months of thirty days each, with an added intercalary month to make the solar and lunar years coincide, was deemed most scientific. Water clocks and sun clocks were invented to measure time during day and night. This scientific knowledge achieved in Babylonia would undoubtedly have been lost forever had it not been for the preservation of the records on the hard, clay-baked tablets upon which are found inscriptions in wedge-writing or cuneiform, a form of writing that had been developed from primitive picture-records. In the field of primitive chemistry the Babylonians were skilled in the making of alloys, in debasing metals, and in constructing imitation jewels. Their simple geographical study sufficed for classifying all the tributary nations and plotting itineraries of travel by means of hours for reckoning distances, for the convenience of caravan merchants and governmental diplomats. A world map was drawn, setting forth the earth as a round flat surface with the cities and villages designated by circles. Medicine included prescriptions of vegetable and mineral substances, and later animal materials. Heat was used as a healing agent, while massage and medicated oils were also employed as means for cures. The lists of plants, birds, stones, insects, and fishes suggest the beginnings of botany, mineralogy, and zoölogy. The Babylonians were also expert manufacturers of metal, glass and clay ware; of linen, tapestries and muslin. Babylonia was in its day the scientific teacher of the world.

But there were many influences in Babylonia that colored and modified the observations of the priestly scientists. The gods were to be sought in the heavens and not on earth, thought the priests; and the heavenly bodies—the sun, the moon, and the five known planets—were deities of the Babylonians. Hence the supreme purpose of the observation of the heavens was to learn the will of the gods, not to discover and describe scientific laws. This powerful influence of the star gods upon the fortune and fate of monarchs, of nations and of men, developed into a very elaborate fortune-telling "science" of astrology. Henceforth the positions, movements, changes and relations of a star deity became the chief concern of the priestly scientist.

The belief in good and evil spirits was another factor that hindered science from becoming completely scientific. The power of magic was the dominant force in all Babylonia and the arts of divination, spells, incantations, omens, sorcery and exorcism were highly developed. The priests employed white magic to control good spirits, and the warlocks and witches, deformed and peculiar people, were accredited with expertness in manipulating black magic to master demons or evil spirits. Thus scientific achievements in astronomy were paralleled by unscientific astrological and magical practices. Side by side with the true understanding and prediction of eclipses was the false prediction of the fortunes and fates of humanity by means of codes of destinies for the interpretation of heavenly signs. The treatment of a sick person included not only prescriptions of vegetable and mineral compounds but also spells and incantations to drive out the evil spirits that were deemed the cause of illness. A plague or an epidemic was due to the purposeful activities of the deities of the stars or the spirits of earth, and was removable only by magic arts.

The Babylonians were also keenly interested in delving into questions regarding the origin of the universe, of the earth, of humanity and institutions. Their world was a disk surrounded by an ocean, with Babylonia the center of the universe and the major part of it. The foundation of this flat earth was water. Within the earth was the abode of the deceased. Above the earth was a solid dome, with entrance and exit doors for the sun and moon. An ocean rested on the dome and was the foundation for heaven above. The universe was created out of chaos by an instantaneous divine command. The Babylonian earth was flat and stationary, the center of the universe, created by decree and controlled by gods and good and bad spirits. This Babylonian cosmogony was more of a religious interpretation than a scientific explanation, since religion so thoroughly dominated science. The discoveries of libraries of clay tablets have revealed remarkable stories of creation, a garden of paradise, a universal flood, the sabbath and the tower of Babel. All this is of fundamental importance because Babylonian science was to provide in the years to come the basis for the attitude of the Hebrews toward science. But the Babylonian world view was colored by current crude polytheistic religious ideas, while the Hebrews viewed the world through the nobler religious ideals of a growing monotheism. Although the science of Babylonia and Israel was essentially identical there was a colossal difference in the religious conceptions of the two peoples.

Egypt was another pioneering nation in the realm of ancient science. Here also, as in Babylonia, the interest in science was developed not for the verification of hypotheses and the discovery of natural law but rather for the sake of meeting practical needs of daily life. Applied science, not pure science, was the goal and the achievement of the Egyptians.

Constant surveying was made imperative because of the wiping out of landmarks by the floods of the Nile. This necessitated an accurate method of land measurement, and simple mathematics evolved into the science of geometry. A system of irrigation was developed to control the precious water which the river supplied. Ditches were constructed for its effective distribution and reservoirs for storage of the surplus. Dikes were built to prevent the waters from reaching towns and gardens. Many acres of marshlands were drained and made fit for cultivation.

The need of ascertaining in advance the approximate time of the next flood gave rise to the study of the stars, the creation of a calendar and the application of mathematics. The Egyptian astronomers drew sky-maps or charts of the heavens and identified the prominent fixed stars. Star positions could be determined by the use of simple instruments, thanks to the wonderfully clear atmosphere of Egypt. The Nile has been justly termed the father of Egyptian science.

The engineering and mechanical skill thus acquired was employed also in the building of temples, pyramids and sphinxes. The ground plan of the base of the Great Pyramid of Cheops at Gizeh is practically a perfect square. So accurate were these ancient builders that engineers of to-day have detected only the minutest errors, one three-hundredth of a degree in angle at the corners and sixty-five one-hundredths of an inch in the length of the sides of the base. The achievement of assembling and erecting such enormous quantities of materials has been the wonder of the engineering world. It clearly reveals a knowledge of the inclined plane, the lever and the pulley. The art of stone masonry thus developed had its scientific basis, and it gave to the world the clerestory, the colonnade and the column.

In meeting the needs of the body the Egyptians led their world. Writes the ancient Greek historian Herodotus: "The art of medicine is thus divided among them; each physician applies himself to one disease only, and not more. All places abound in physicians; some physicians are for the eyes, others for the head, others for the teeth, others for the intestines, and others for internal disorders." This would imply that each doctor was a rather narrow specialist, treating one particular part of the body and diseases affecting that part. He was not a general practitioner of correlated medical intelligence and skill.

But in medicine in Egypt may be seen the birth of science. A noted Egyptologist comments significantly upon the Edwin Smith Papyrus, a seventeenth century B.C. copy of an older Egyptian medical work:

> It is the earliest known really scientific document; for in it we find the human mind for the first time endeavoring in the first place to discern and record facts and then to base conclusions upon these facts. It is a treatise on surgery and external

> medicine. . . . It contains the earliest known observations on the human brain and indeed the word "brain" occurs in it for the first time in any known written document. Surgical stitching is mentioned for the first time in medical literature.[2]

Advanced as was Egyptian medicine for its day it was still very elementary and rudimentary. Although observations played an important part in the study of diseases and the application of remedies, still disease was supposed to be caused by hostile spirits. In the final analysis the physician was also a combination of magician and priest. The scientific practice was largely nullified by unscientific theory, having to do with magic or religion or both.

Religion in manifold forms dominated the minds and lives of the people of the Nile valley. It ranged all the way from the worship of animals and ancestors and nature to the veneration of one supreme deity. Bulls, crocodiles and other animals were thought to be sacred. The heavenly bodies, the forces of nature, rivers, trees, mountains and rocks were also held in great reverence. Good and bad spirits were powers to be dealt with in daily living. The greatest nature deity was Re, the god of the sun, and the pyramid was his sacred symbol enshrining the mummies of kings. Osiris, the other great nature deity, embraced and ennobled the waters of the Nile, thus giving productiveness to the soil and assuring the fruits and grains of the harvest. The deities were later deemed all-powerful in the moral values of life, not merely the physical and the material. Even prior to this development the national sun god Re had been conceived in terms of internationalism—had became a world deity; and thus monotheism was born. Some advanced Egyptians recorded their beliefs on the monuments: "God is a Spirit: no man knoweth His form. He is the creator of the heavens and the earth and all that is therein." But monotheism and these high spiritual ideals never became the general religious conceptions of the land. Exclusive belief in the sun god Re was established by one of the Egyptian rulers, Amenhotep IV, 1375 B.C. He wrote hymns expressing his belief that Re created all living beings, that he was a kindly father, caring for all his creatures. But when this ruler passed from the royal scene the old medley of faiths soon reappeared, and the gleam of monotheism faded until Hebrew times.

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[2] J. H. Breasted, *The Conquest of Civilization*, p. 88.

The astronomy of Egypt was colored by astrology, as was medicine with magic, and religion controlled all branches of learning and phases of thought. The earth was believed to be a flat, long table, with high pillars at the four corners to support a gigantic metal firmament or sky-dome. In this firmament stars pierced the metal to give light and entrances and exits provided for sun and moon. Above the firmament were waters, which passed to the earth through "windows." The cosmogony of the Egyptians assumed a world of matter without form, created instantaneously by a deity. It is believed that the Babylonian conceptions of the origins of the world influenced the world views of the Egyptians. The science of the Egyptians possessed grave limitations. It never freed itself from superstition, and it was almost exclusively applied rather than pure science, for with respect to both this life and the life to come the Egyptian was primarily interested in practical affairs, in things useful and utilitarian. He did not pursue science for truth's sake, but for the sake of meeting needs of daily life. Yet he made a splendid contribution, which would some day serve as an incentive and a heritage for those outstanding scientific pioneers, the Greeks. While the Egyptian had no rational theory or hypothesis of the heavens or of the beginning of things, regarding such speculation upon abstract questions as of little or no practical value, still his achievements in the fields of astronomy, architecture, engineering, mathematics, irrigation, agriculture, and medicine are among the great early landmarks in science.

Greece was the greatest scientific nation of the ancient world, building on Babylonian and Egyptian foundations. But instead of utilizing science to serve the interest of religion, or for the invention of devices for practical living, the Greeks sought the discovery of great truths, laws, and principles of science. The Babylonians and Egyptians had been concerned chiefly with applied science, whereas the Greeks went back to theoretical origins, to pure science, and thus laid the foundations for unlimited scientific growth and progress.

Thales, a prime mover in the bringing of Oriental science to Greece, was a pioneer both as philosopher and as scientist. He sought an explanation of the origin of the universe and of life in natural causes, not in supernatural decrees. From Babylonia he secured the astronomical records, and by their analysis he was able to teach the Greeks how to predict eclipses as the Babylonians had done centuries before. Thales traveled widely, spending considerable time in Egypt studying methods of astronomical observation and recording of events, and the application of geometry in the reëstablishment of landmarks after an overflow of the Nile. Introducing these applications of Oriental science into Miletus, and thence into Greece, Thales continued his studies, advancing hypotheses that the earth was a circular disk floating on water, that the heavenly bodies were not deities but bodies of fiery matter, and that water was the universal principle of nature. A fellow scientist at Miletus, Anaximenes, disputed the water theory and advanced the hypothesis that air was the first cause of all things. Anaximander modified both theories by asserting that the first principle was an animated mass of a nature between water and air. Thus we enter upon the first era of pure science.

Pythagoras, another Greek, spent some time in research work in Egypt and later settled in Italy where he founded a school of thinkers. He came to the conclusion, astounding for his day, that the earth was a sphere, and revolved on its axis completely every twenty-four hours. The basic elements of the earth were thought to be water, air, fire and earth. Parmenides confirmed Pythagoras' conception of a world sphere. Anaxagoras found in the ruling principle of the universe a "world-ordering mind." He taught that in the beginning all was chaos, and intelligence set all things in order. He became one of the first martyrs of science, for he was fined and exiled for daring to teach that the sun was not a god and that there was a Supreme Intelligence in the universe.

The father of Greek medicine, Hippocrates, set forth the scientific truth that disease was due to natural causes and must be cured by natural means; it was not due to the punishment of the gods, or to demons, and it could not be cured by exorcizing rites; there must be a careful study and observation of clinical methods, and disease was in great measure to be cured through nature herself.

Aristotle, the father of the science of zoölogy and the greatest of all Greek scientists, was most outspoken in his belief that the earth was round, although his rejection of the doctrine of the earth's motion impeded science for years. He was a prolific writer on scientific subjects, recording and evaluating the discoveries of astronomers, tracing in his work on zoölogy a continuity from the lowest plant to the highest animal, noting the twilight zone of plant and animal life where absolute classification seemed impossible. He also assembled large collections of botanical and zoölogical specimens for research work.

> Taken as a whole, his work represents the culmination of the scientific genius of the Hellenic race. He was the first individual of whom it is recorded, that *he took notes and collected books, with a view to an encyclopædic organization of existing knowledge*. . . . He was the greatest systematizer of knowledge that the ancient world produced, and was in general the founder of most of the sciences which originated in the ancient world.[3]

One of Aristotle's pupils, Theophrastus by name, became interested in plants and as a result of a study of five hundred specimens, which he classified as trees, herbs and shrubs, he gained the title of father of botany.

When Alexander the Great conquered Greece, and the spirit of liberty and freedom in scientific pursuits vanished, the research work was transferred to Alexandria, where from 300 B.C. for seven hundred years Greek science had its headquarters in the city museum or university, which was equipped with a wonderful library and with dining hall and lecture rooms. The curriculum included such subjects as "healing art, anatomy, mathematical science, geography and astronomy." After three hundred years of scientific progress in Greece, Greek science returned to the land where Thales had received his inspiration, to add to the early Egyptian science of applied knowledge the spirit of pure science, which is the spirit of progress.

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[3] W. C. Curtis, *Science and Human Affairs*, pp. 34-35.

The Alexandrian museum represents the earliest institutional attempt at the systematic organization and extension of scientific knowledge. The science of Alexandria did not restrict itself to observation, but relied also on experimentation.

Archimedes, a leader in the realm of mathematics, discovered the principle of the lever, and also the weight of bodies immersed in water. He was the first to measure the specific gravity of different substances. He made important contributions to algebra and geometry and laid the foundations of mechanics. Euclid, another great mathematician, wrote his thirteen volumes on *The Elements of Geometry*, a model for clearness, brevity and accuracy.

The Greek astronomer, Aristarchus, discovered that night and day are caused by the earth turning around on its axis every day. He believed that the sun and fixed stars were immovable but that the earth traveled around the sun.

Erasistratus and Herophilus, Alexandrian physicians, became the founders of the science of anatomy. They conducted extended experiments in the dissection of human bodies, carefully recording their results. Eratosthenes was the supreme pioneer in developing the science of geography, mapping the known world and describing the lands of Europe, Asia and Africa. He attempted to measure the circumference of the earth and is noted chiefly for "having laid down the first parallel of latitude." He was the librarian of the Alexandrian library and established the foundations of mathematical geography.

The precession of the equinoxes was discovered by Hipparchus, although he did not know that it was caused by the sun and moon. He made a star catalogue of a thousand stars, which served as the standard for nearly sixteen hundred years. He also determined the length of the year within six minutes of complete accuracy. He is given credit for laying the foundations of the science of trigonometry. Ptolemy used the discoveries of Hipparchus as the basis for his astronomical studies some years later.

Claudius Ptolemy, the disciple and successor of Hipparchus, in the second century A.D. formulated the first complete treatise on the science of astronomy of his day and age, entitled *The Almagest*. Although a geographer as well as an astronomer he is best known as the founder of the Ptolemaic system of astronomy: the explanation of the movements of the sun, stars and planets which supposes the earth to be stationary in the center of the universe. His work was the standard authority for almost fourteen hundred years, and no important astronomical advance was made for nearly a thousand years. Astronomer, geographer and mathematician, Ptolemy held that the earth was the center of the universe, and that the sun, moon and stars revolved about the earth daily. Inspired by discoveries in Babylonia he founded a world-famous school of science, endowed with a magnificent museum and library.

The Greeks were the first to separate science from religion. Instead of invoking deities or cajoling spirits they suggested such first principles as air, fire, water, number, mind and atoms. Their aim was to discover the facts of nature, for they were not primarily concerned about origins. The foundation for their science was the method of observation, limited experimentation and organization of results, but their discoveries and inventions were at times incomplete and inaccurate due to the mingling of speculation with scientific observation. Not having the tools and instruments for more accurate testing they gave the best they had, a wonderful contribution as far as it went, requiring, however, adjustment and correction by scientists of later ages. While the scientific heritage left by the Greeks is superb, their philosophical and literary contributions are even greater. The gift of speculative philosophy dominated their life. While their forebears in science in Babylonia and Egypt were specialists in applied science, correlated with magic and religion, the Greeks were specialists in pure science correlated with philosophy.

The Greek religion at first was concerned with a host of spirits, good and bad, whose favor must be won or hostility avoided. The sky, the earth, the sea, mountains, trees, springs, forests, and rivers all were possessed by spirits, whose sway and power were limited to their own realm and functional activity. These spirits grew into gods and goddesses of major and minor importance. Powers resident in the objects and forces of nature were clothed with the attributes of mankind, and as such became the protecting deities of cities and towns and communities. As impersonal spirits thus evolved into personal deities the number and importance of their functional activities greatly increased. By a process of religious elimination, in an evolutionary competition, the major gods emerged in supreme control, with the sky deity, Zeus, as religious emperor of the Greek pantheon. As fear held less sway among the Greeks than among the Babylonians and Egyptians there was little fear of the spirits and deities; but side by side with the expression of freedom, of beauty and of friendliness in Greek life, and in the life of the Greek deities, were the baser aspects of human life, and the vices and crimes of which men were guilty were thought to be a normal phase of the life of the gods.

The deities were supposed to be in constant communication with their worshipers. The institution of the oracle was established, and trances and mystic rites served to transmit the will of the gods, through the mediation of priests and priestesses, to the worshipers. The interpretation of dreams, of lightning, of the wind, and the rustling of the leaves of the sacred oak, was a means of ascertaining the will of the deities. The immoral and dishonest deeds and words of the gods came to be questioned, and a minority of the Greeks added morality as a basic essential in the character of the gods, but more and more these thoughtful Greeks turned to philosophy and neglected the religion of their fathers. Others, awakened by a sense of unworthiness, in order to establish personal relations with the gods supported an emotional type of faith dramatized as "the Mysteries," which offered an intimate communion with deity that cast out sin and assured purity and happiness. But the oracles and the mysteries did not provide a cosmogony that would satisfy the keen Greek intellect. In seeking for an explanation of the origin and functioning of the world, of humanity, and of deity, philosophy and science discovered that there were fixed laws in the universe, and Greek religion from its very nature was powerless to protest. There was no sacred book that was authoritative, no dominant theology, no universal system of religious education, no intrenchment of a powerful heirarchy or priesthood. Homer had provided in earlier times a theological cosmogony of a flat disk earth, completely surrounded by a large river, out of which the heavenly bodies emerged each day and to which they daily returned, and Hesiod had sponsored a somewhat similar view of things. But such cosmic theories did not greatly hamper the speculative philosophers and observing scientists, who were given free rein in their effort to discover the natural laws that were instrumental in the origin of the universe and still were operative. Thus the supernatural declined as the natural conceptions grew. The Orphic poets tried to give the Greek world a cosmogony in which Zeus was the primal source, the creator, the controller of the heavens, the earth, humanity, and the forces of nature. Dionysius was likewise made supreme in creation. But these attempts at theological explanations of cosmic origins did not succeed.

When the West finally seized Greek science learning became virtually forbidden. The East nominally taught it, and preserved it; while the West nominally preserved and straightway forgot or lost it. The Greek love of philosophical speculation was turned from science to the making of Christian theology and creeds, and disputes and councils of the church bespeak the activities of many ex-Greek scientists and philosophers. Things turned out, indeed, much to the disgust of the Western church, whose aim in wiping out science was to remove the cause of heresy, which resulted from theological speculation. The church in the West was mainly interested in practical organization and expansion, following the characteristic Roman bent.

Gradually the applied scientific spirit of the Romans and the hostility of the Christian church standardized and mummified the achievements of Greek science, as the free spirit fled first to Alexandria, and then to India, to be revived centuries later by the Arabs in the Middle Ages. The spirit of freedom of inquiry, and love of truth for truth's sake, received the first paralyzing stroke when Alexander the Great conquered Greece, the second stroke when Rome incorporated Greece in her empire, and the third when the Christian church became theologically and administratively supreme in the Roman world.

Thus the era of the decline of Greek science is largely synchronous with the age of the prosperity of Roman science.

Rome adopted the applied scientific spirit of the Babylonians and Egyptians rather than the pure scientific spirit of the Greeks. The Romans were interested in the utilitarian aspects of science as applied to practical daily activities, not in the pursuit and discovery of truth or in the abstract formulation of theories in order to explore principles and laws.

The Greek mind was essentially speculative and philosophical, given to abstract, creative, scientific research. Rome went to the school of Greece and absorbed Greek culture and science, but the Greek love of speculation, of theorizing, of questioning, and of probing, never gained the ascendancy in the Roman empire. The Romans were imitators rather than creators in the field of science.

The Roman mind was characterized by utilitarianism, practicality and pragmatism, and as a result in the realm of applied science the Roman genius holds sway. Whatever would benefit the empire was utilized to the utmost, and applied science is therefore expressed in mighty building achievements, paralleling those of the temples in Babylon and the pyramids in Egypt. The building of cities of roads, and military works—city walls, triumphal arches, temples, palaces, theaters, amphitheaters, baths, fortresses, bridges, and aqueducts—these are the scientific engineering achievements of the Romans. Law, political administration and applied science are natural expressions of the Roman mind.

There were but a few minor creative scientists in the Roman Empire, and they were either of Greek nationality or large borrowers from Greece. Rome, however, was not hostile to Greek pure science; she was merely indifferent to it. Her administration of law and order afforded for a time an admirable check upon the barbarians, who otherwise would much earlier have swooped down and wiped out the scientific centers at Alexandria and elsewhere.

Strabo, a Greek, a noted scientist of the Roman world, wrote a treatise on geography in seventeen volumes, embracing both a general summary of the works of previous writers and a record of the author's own travels. Strabo held to the belief that the earth was the center of the universe, that it was immovable, and that around it revolved the sun, moon, and stars.

Pliny, the Roman naturalist, wrote a series of thirty-seven books on natural history, rather an encyclopedic compilation than a creative work of scientific research, revealing the borrowing and imitative spirit of the Roman scientists. The work treats comprehensively of the sciences of astronomy, biology, geology and chemistry.

Galen, another Greek, was the most famous physician-scientist of the Roman world, receiving his medical training in the Greek schools of medicine in Alexandria and Pergamum. A wide traveler and student, he finally was appointed court physician, serving the emperors Marcus Aurelius and Commodus. He discovered two sets of nerves, the nerves of sensation and of motion. He elaborated a theory of medicine, with the result that his medical rules became the unchangeable standard and authority for the Middle Ages, as Ptolemy had become the standard for astronomy. But in the main Galen was more a compiler of Greek learning than a creative medical scientist.

Lucretius, an outstanding Roman poet, was the author of a poem, *Concerning the Nature of Things,* which is of scientific value, even though it is in reality an exposition of philosophy. He suggests the origin of the world from atoms in motion, the progressive production of life by spontaneous generation, the evolution of man from an animal ancestry, the development of language from animal sounds, the origin of religion from dreams, but his chief scientific contribution is his distinction between superstition and magic on the one hand and reason and the laws of nature on the other hand.

Julius Cæsar reformed the calendar, introducing the Julian calendar, the year consisting of 365 days with an additional day in February every four years. He also began a survey of the empire which was not completed until the age of Augustus. His assassination cut short his vast engineering plans, including the rebuilding of the city of Rome, the construction of new roads, and the digging of a sea canal through the Corinthian isthmus.

In the field of architecture the Roman Vitruvius was the author of a text that became the supreme authority for architects not only in the reign of Augustus but down through the Middle Ages to the Renaissance. It is a compilation of the work of earlier Greek and Roman authors plus an original contribution. A Roman army engineer who had traveled much and had wide military and building experience, Frontinus by name, wrote a book on the waterworks of Rome.

Many were the mechanical inventions, the construction, building and engineering achievements of Rome. Many also were the compiled works which she produced, works based on Greek authors, with little or nothing in the way of Roman creative additions thereto. The great structures—military, civic, religious—are Rome's applied scientific gifts.

What was the nature of the religion of the Romans, the characteristics of that faith and its attitude toward science? Before coming in contact with the pantheon of Greek deities the Romans possessed a faith that peopled the objects and activities of nature with spirits, each with a particular function. These spirits graduated into the class of deities with the same or added functions, and these deities were not completely humanized as was the case in Greece, but rather remained vague, shadowy, a sort of impersonal beings. The functions of these spirits and later spirit-deities related to the home, to agriculture and stock raising, and to war. Everything and every act to the Roman possessed a mysterious and supernatural significance. There was no need of images of the gods, since every object and activity was the dwelling place of a deity and expressed that duty's will. Worship aimed at winning the favor and averting the disfavor of the gods. The deities were thought ever to be revealing their wishes in signs. Worship consisted in correct and exact observance of ritual.

There arose two classes of religious officials: pontiffs, who had charge of the general administration and supervision of religion, the ritual, festivals and calendar dates; and the augurs, who were diviners, or the interpreters of the omens of the deities, such as the flight of birds, the appearance of the entrails of animals, lightning and thunder, etc. The Roman's religion was essentially legal, political and practical. These officials of religion were elected and controlled by the state. No theological or specialized training was a prerequisite. They were elected to administer with precision the religious ritual, for the welfare of the state. There was no opportunity for the domination of a hereditary and powerful priesthood, dictating the policies of state. The Romans had entered into a contract to worship certain deities by means of ritual, sacrifices, and festivals, in return for the specific aids to welfare each god was empowered to bestow. The essence of religion was solemn and binding ceremony, with the purpose that the will of the gods might be determined before entering upon any important act in the life of a person or the state.

Religion was never a dominantly exclusive affair in Rome. There was ever a tolerance of foreign gods, an admission of the important functions of non-Roman spirits and deities in assisting other peoples. Naturally as the empire came to embrace one conquered nation after another, the deities of these conquered peoples were hospitably incorporated in the Roman pantheon. Gods from Etruria, Greece and the Orient received the official stamp as belonging to recognized faiths or having their rightful place in the federation of religions. The Greek idea of deity, the definite humanization and representation by a statue or image, came to supplant the impersonal conception of the older Romans. Later there was added the worship of the emperor, a kind of a state patriotism with appropriate ritual. The mystery religions became very popular, and many intellectuals became deeply interested in the Stoic and Epicurean philosophies. Babylonian astrology exploited by Chaldeans or Oriental magi came into vogue to interpret the individual's future and destiny. Judaism had spread throughout the empire since the Jews had migrated into every city and hamlet for purposes of trade and commerce. With such a medley of faiths, of deities and types of ritual and beliefs, there was no unified attitude toward science. Religion and science in Rome were instruments of the state, and the thoroughgoing practical nature of each precluded any clash regarding cosmogony.

Yet factors and influences were leading toward the disintegration of science which was to accompany the fall of the Roman Empire. The Roman attitude toward pure science had greatly lessened the interest in scientific research. The conquest of Greece by Alexander the Great and later by the Romans had undermined the Greek devotion to freedom of thought and inquiry and the pursuit of truth for truth's sake. The one-sided Roman loyalty to the state, militarism, slavery, the development of urban at the expense of rural life, the prevalence of malaria and other diseases, race suicide, depletion of the best blood through wars, political rivalries, soil-exhaustion, immorality, divorce, infanticide, the cruelties of the arena and the onslaughts of the barbarians, all combined to wreck the Roman Empire and with it the civilization, the culture, and the science of the Græco-Roman world.

The swooping down of the barbarians upon Rome and the subsequent jealous wrangling among the tribes over the final allotment of their booty cast the spell of the Dark Ages over Europe, a time of lawlessness, destruction, and violence, the shock of which was felt for almost a thousand years. The one outstanding institution that successfully withstood Roman persecution, barbarian insults, and debasing morals was the Christian church. There was little time for the defenders of the empire, the hunted Christians, or the primitive barbarians to develop either pure or applied science. Not only was there no time for such pursuits in the West, but there was little or no interest in science. Gradually, however, the growing church which was to be the arbitrary authority and power in the Middle Ages evolved attitudes toward all institutions and activities of life, including an unfortunate attitude toward science. On the model of the Roman system of administration of law and order the church built a magnificent ecclesiastical organization, especially in the West. Building on the philosophy of the Greeks the church in the East developed an elaborate theology. The church first favored and then condemned ancient science, finally tolerating a standard theory and practice of science that conformed to its theology and beliefs, its sacred books, council decrees and creeds, approving Babylonian-Hebrew rather than Græco-Roman science as its standard.

CHAPTER II

HEBREW SCIENCE AND CHRISTIANITY

The Hebrews inherited and shared the science of the ancient world. They were not destined to be pioneers of primitive applied science as were the Babylonians and the Egyptians; nor were they to be leaders in the realm of pure science as were the Greeks, or paramount as adaptors of applied science as were the Romans; yet the Hebrews were not unacquainted with the scientific learning of the Mediterranean world.

The achievement of a noble monotheistic religion was the supreme contribution of the Hebrews, a religion which would outgrow polytheism, astrology, and magic, and throwing off tribal limitations would finally assume a universal character. Religion placed in subjection to it all scientific, artistic, philosophical and educational interests, and truth was sought not for truth's sake but for the sake of knowing and doing the will of deity. The Hebrews did not think in terms of secondary causes such as natural law, but rather in terms of first cause or deity, at work directly or indirectly through divine creatures, spirits and human beings. They were interested in science and the world of nature primarily as an aid to religion, and while not minutely exploring the natural world they adopted and adapted the science of an ancestral nation of the Orient, rejecting a large measure of magic and superstition while naïvely reading the agency of deity into the accepted science.

The Hebrews were originally nomads of the desert, tending their sheep, living in tents, engaging in blood-revenge feuds, worshiping in fear many deities thought to dwell in rocks, fountains, trees, mountains, animals and heavenly bodies. Gradually these manifold spirits became unified and personified, and each clan or tribe entered into a covenant with a major deity, to worship and support that god in return for security and protection. As the tribes wandered from the desert to Babylonia or Egypt or Sinai or Canaan they frequently adopted such deities as seemed then to be needed, due to environment, occupation, the peculiar forces and activities of nature, and the enemies to be encountered. They also dropped by the wayside the deities that were no longer of service to them. In connection with this process of religious addition and substraction, so common in the life of ancient peoples, it was most natural that in a time of stress and storm, when a great crisis confronted a tribe or tribes, a covenant or contract should be entered into with a new or an old deity, to secure needed help and support.

Driven by famine in their desert wanderings to the vicinity of the fertile valley of the Nile, a number of Hebrew tribes established friendly relations with the Egyptians. Years later a Pharaoh pressed them into arduous servitude, to complete his extensive engineering and building projects. Resenting the cruelty of one of the Egyptian labor overseers, a Hebrew committed a crime and fled for his life to the Sinai region, where he spent years of exile with the tribe of Midianites. Here Moses entered the employment of a priest, Jethro by name, and made such a favorable impression upon his employer that he gave to him his daughter in marriage. All the while in the desert solitudes tending sheep, or in the companionship of the priestly family or the social and religious life of the tribe, this Hebrew was coming to know intimately the deity of Midian, the desert-storm deity of Sinai, Yahweh.

Sinai was a sacred land, presided over by the deities of storms, mountains, mines and laws, long before the arrival of the Hebrews from Egypt. The Egyptian deities who were the officially delegated guardians of the mountains and mines of Sinai were Supt, the hawk god, and Hathor, the sky goddess. The Babylonian deity, Sin, the moon god, was the guardian of law and was associated with Sinai, supposedly giving the name to this region. The Midianites and other tribes in this area worshiped a chief desert-storm deity who expressed himself in thunderbolts, lightning, clouds, rain and earthquakes. The Babylonians preserve a tradition of the giving of a code of laws by a deity whose abode was a sacred mountain. The civilization, culture, religion and science of Babylonia had profoundly influenced Canaan and the Sinai region for many years, and the Hebrews were about to enter these two areas.

Inspired by the conviction that Yahweh, the deity of might, would free the enslaved Hebrews, and trusting in his strength, Moses led forth the Hebrews from Egypt to Sinai, the sacred abode of the deity. Here Yahweh was formally presented to the Hebrews by Jethro, the priest of the Midianites and Yahweh's chief representative. Jethro thereupon officially celebrated a sacrificial sacrament in the presence of the Hebrews; Moses led the Hebrews in the formal ratification of the covenant with Yahweh; and the Midianite deity of war, because of his deliverance of them from Egypt and his power to enable them to conquer Canaan, became the outstanding god of the Hebrews. This suggests a military alliance with the Midianites, for later the Kenites, a branch of the Midianites, were allies of the Hebrews in Canaan.

Moses was in no sense abolishing the other deities worshiped by the Hebrew tribes and establishing monotheism. Yahweh was to enjoy supreme but not exclusive worship, as the powerful super-god of war, and in turn he was to give special consideration and protection to the Hebrews. Yahweh was the chief deity, uniting the tribes, and in such a position was in direct line of succession for exclusive worship and monotheism, but from the thirteenth century, when the Hebrews entered Canaan, to the reform of Josiah in 621 B.C. polytheism and idolatry existed side by side with the worship of Yahweh. There was a vigorous and ever-growing minority of exclusive Yahweh supporters, who insisted upon the abandonment of other gods, and finally in 621 B.C. the worship of Yahweh became the official religion of the Hebrews.

When they entered Canaan the Hebrews were confronted with a civilization much older and higher than their own. Here were cities fifteen hundred years old, strategically located, fortified by strong walls; and here were warriors who knew well the arts of warfare. The government was stable; the people lived in well-appointed houses, tilling their fields, plying their trades, engaged in commerce. There were professional literary men who could read and write. The people wore clothing of woven wool. The Canaanites had laws, traditions, culture and religion.

The civilization of Canaan was based on the much older culture of Babylonia, which traced its records to about 4500 B.C. As early as 2200 B.C. Babylonia was the economic, scientific and religious center for all of western Asia, including Canaan. Even down to 1358 B.C. Babylonian might was felt not only in Canaan but even in Egypt. Babylonian soldiers and traders had carried with them to Canaan the civilization and culture of their native land. They brought the achievements of law based on the remarkable code of Hammurabi of the twenty-first century B.C., which in turn was based on older codes. They brought the accomplishments of science: mathematical skill, astronomical observations, architectural knowledge of the round arch and vault for buildings, and medical technique. They brought also their religion, their astrological and magical arts, and their cosmogony. Thus Canaan inherited the ancient and advanced civilization of Babylonia.

The incoming Hebrews were a striking contrast to the Canaanite inhabitants. They were in the infancy of their national existence, having no records that went back further than about 1275 B.C. and no absolutely authentic records earlier than the ninth century B.C. They entered Canaan as a rough, unlettered crowd of tent-dwellers and herdsmen, clad in sheepskin. Their background was that of the desert and of Egyptian slavery. They were without the higher arts of civilization. Their religion was polytheistic, with a mountain deity, adopted as a tribal act of military necessity and intertribal unity, in a position of preëminence. They had no science, no art, no written literature, no code of laws, no cosmogony; they could not read and write. They were about to enter a Babylonian-Canaanite school. Those who settled in the north of Canaan, where town life was well established, proved to be expert assimilators and adapters, while those in the south clung to the old desert customs, refusing to leave their tents and sheep. Thus a natural cleavage and two distinct types of tradition arose among the Hebrews in Canaan. Those in the north adopted the higher civilization and intermarried with the Canaanites, with the resulting racial acquisition of the Hittite countenance. They built houses, wore clothing of woven wool, entered into business and commercial intercourse, and were blending their religion with that of the Canaanites. They came in contact with Babylonian law, science, literature, traditions and cosmogony. Many stories were transmitted to them by the Canaanites—Babylonian legends with Canaanite modifications—and there were also Babylonian traders traveling through Canaan who related legends at first hand.

Babylonia was the supreme teacher of science in the land of Canaan, and in turn became the instructor of the Hebrews when they entered this land through piecemeal conquest and a tolerated assimilation. For a long time it was a question whether or not the Hebrews would be completely absorbed by Babylonian culture. What would the Hebrews do with a Canaanite polytheistic religion accompanied by debasing rites; an elaborate system of astrology, a well wrought-out technique of magic, and many wonderful scientific discoveries and inventions ; ancient traditions explaining the origin of the universe, of humanity, of catastrophes, and institutions?

The Hebrews were engaged in the tremendous task of achieving monotheism. They struggled against polytheism and the iniquitous ceremonies. They fought astrology and magic, and since science was closely allied to superstition they made it of secondary importance, utilizing only what might be incorporated into the concepts of a monotheistic faith. As a result the ancient traditions of the origin of the world and of life were retained in their primitive prescientific structure, the direct agency of Yahweh, now conceived as the one supreme and only deity, being substituted for the innumerable deities of the Babylonians. The fundamental feature of Babylonian faith, that religion was to be central in all phases of life, also was retained. Whatever science remained in the Hebrew scheme served primarily to explain religion or to interpret the will of deity.

When and how did the Hebrews acquire the science of the Babylonians? The ancestors of the Hebrews came originally from Babylonia. The culture of Babylonia had long dominated Canaan before the Hebrews began their conquest, and following the conquest the Hebrews absorbed this culture most completely. Some centuries later many of the Hebrews were carried captive to Babylon. It is natural therefore, from these many contacts, that the Hebrews should have acquired, directly and indirectly, the Babylonian world view, cultural traditions and early code of laws. The stories in the Hebrew genesis of the creation, the flood, the sabbath, and the tower of Babel find striking parallels in what has been termed the Babylonian Genesis. Several explanations have been suggested:

One theory is that the Hebrews acquired Babylonian science after the conquest of Canaan. Since the civilization, culture and influence of Babylonia had for centuries been dominant in Canaan, and since the Hebrews so thoroughly adopted the Canaanite customs and manner of life, rising as they did from a lower nomadic stage of living to that of a higher agricultural life, it is obvious that Babylonia, the scientific teacher of Canaan, was also the teacher of the Hebrews, though allowance should of course be made for Canaanite modifications of the Babylonian heritage.

A second theory supposes that Babylonian science was acquired by the Hebrews after they were exiled to Babylon. In this period their religious leaders, having ample time at their disposal, may have written a religious history of their nation; or they may have written this history upon their return to Jerusalem. At any rate the suggestion is that coming directly into contact with the magnificent civilization and science and world views of the Babylonians they revised their own traditions, bringing them up to date but carefully eliminating all traces of polytheism in their effort to establish a pure monotheistic faith.

A third explanation is to the effect that the Babylonian science itself goes back to a tradition which was common to both Babylonians and Hebrews. This view that the two accounts represent different developments from an earlier tradition is supported on the grounds of the extreme divergence in their spirit and essential statements, the one presenting a realistic polytheism and the other an idealistic monotheism.

There is finally a fourth suggestion that the Hebrews made Babylonian science their own before and during their enslavement in Egypt. The Semites, of which race the Hebrews were one of the important representatives, in their wanderings in earlier ages had settled in the Babylonian region. Through oral transmission traditions spreading from tribe to tribe might easily have reached the Hebrews. That Moses and the Hebrews would become acquainted with the Babylonian scientific views in Egypt, since Babylonian influence was widespread even in the Nile valley, is also not unlikely.

Whether the Hebrews derived their science from a pre-Babylonian source, from Babylonia remotely through nomad tribes, while enslaved in Egypt, after the conquest of Canaan, or directly while in exile in Babylon, the fact remains of the overwhelming similarity of the Hebrew and Babylonian world views and primitive scientific accounts of cultural origins.

The Hebrew account of creation is a monotheized and moralized version of a Babylonian or pre-Babylonian record. The order of creation in the second chapter of Genesis corresponds to that of the Babylonian clay tablet. The Hebrew institution of the Sabbath corresponds to the Babylonian Shabattum, which was observed the seventh, fourteenth, twenty-first and twenty-eighth days of the lunar month. The story of Noah and the Flood, of the tower of Babel and the dispersion of the nations, of Moses' birth and exposure, have Babylonian clay tablet parallels. The Hebrew cosmogony of Genesis I, and of the Psalms, the Prophets and the wisdom literature, reveals kinship with the Babylonian cosmogony of the seven tablets. The language of Syria was at one time Babylonian. Solomon's temple was built in imitation of Babylonian models. The same influence is revealed in the designs of fabrics, pottery and sculpture. Even the religious institutions of the Hebrews show Babylonian influence, as do also the utensils used in their ritual. There are striking parallels in the orders of the priesthood and the kinds of sacrifices offered, while the golden candlestick and the table of shewbread in the Hebrew temple had their Babylonian counterparts. There is an indirect relationship between the famous ancient law code of Hammurabi and the Mosaic code which came centuries later. The Hebrews were not the only race revealing such conspicuous parallels, for the civilization of the Phœnicians also shows a striking similarity to that of Babylonia.

The Babylonians pursued their scientific interests as an important phase of their religion, and in a sense they were never able to differentiate the two. They were vitally concerned about science that they might understand and predict the morrow of human destiny —royal, social or personal.

The Babylonian cosmogony depicts a flat earth, resting upon and surrounded by an ocean. Encircling the ocean which surrounds the earth is a high wall that serves as a foundation to uphold the solid vault, or dome, of the firmament over the earth. An eastern opening in the vault allows the sun to enter, and a western place of exit permits it to retire. Above the firmament is another ocean, which is the source of rain upon the earth, and above that ocean is heaven. Within the earth is the abode of the dead. The universe originated from a chaos of water.

The Hebrews inherited the world view of the Babylonians, replaced its polytheistic ideas with conceptions of a noble monotheism, and then transmitted it as a heritage to Christianity. But the basic achievements of the Babylonians in applied science—their practical astronomy, mathematics, and the like—the Hebrews never pursued. Religion, not science, was to be the chief world contribution of the Hebrews, and it is well that they stressed religion rather than a combination of science and religion, mingled with superstition and magic.

The Hebrew cosmos consists of a stationary and flat world, the center of the universe and resting securely upon a world ocean. Above the world is the sky or firmament, in which the sun, moon and stars are placed to give light and warmth to the world. Above the firmament is another ocean, which surrounds the firmament and connects with the ocean which serves as the world's foundation. This cosmos is a three-story apartment with Sheol, later hell, as the first story, the world or earth the second story, and heaven the third story. It was created by divine command, the achievement covering a period of six days and nights.

The Hebrews in their records speak of such a cosmos. We read of the doors, pillars, and windows of heaven, the waters above the firmament, the corners of the earth, the foundations of the earth upon the waters. There were thus three abodes: heaven above, containing the mansions of God, His angels and the good spirits; the earth beneath; and Sheol below the earth, the place of departed spirits, which evolved into hell, the place of devils, demons, and bad spirits. Such was the astronomical world view of the Hebrews.

> Mathematics, geometry and astronomy were looked upon as the peculiar study of the Jews. These were considered as a natural sequence to sacred study and even formed a part of theological lore. Of ignorance in these respects it was said: "Woe to men who see, but do not know what they see; who stand, but do not know on what they stand." Such studies were supposed to lead to a more perfect knowledge of the Creator. The study of the exact sciences was more cultivated in Babylon than in Palestine, and Chaldean and Persian elements found their way amongst the Rabbins.

> Various speculations were pronounced as to the size of the earth and its place in the universe, and the different ways in which the center and then the sides were formed. The Talmud recounts the planets by name. The periods of their revolutions are roughly given. The details connected with the equalization of the calendar and the changes of the seasons are very elaborate, and exhibit both original investigation and acquaintance with the studies of Gentile philosophers.[1]

Medical science was of deep interest to the Hebrews because of its basic religious implications. Entirely apart from physical health and happiness, the cure of disease signified the restoration of right relations with Jehovah. Ill health was supposed to be caused directly or indirectly by the will of Jehovah, as a punishment for sin; it was an expression of the anger and discipline of the Creator. The restoration of health, after repentance, prayer, sacrifice and reform, was also due to the activity of Jehovah, and was a symbol of divine forgiveness and love. That Jehovah is responsible for the cause and cure of disease is explicitly stated in Exodus 15:26: "If thou wilt diligently hearken to the voice of the Lord, thy God, and wilt do that which is right in his sight, and wilt give ear to his commandments, and keep all his statutes, I will put none of these diseases upon thee, which I have brought upon the Egyptians; for I am the Lord that healeth thee." In modern translation the last clause is rendered, "For I, the Lord, make you immune to them." Thus righteousness, virtue, health and the approval of Jehovah were practically synonymous.

[1] Alfred Edersheim, *History of the Jewish Nation,* pp. 352-356.

Dietetic and preventive medicine, rather than remedial medicine, was practiced by the Hebrews. Pure air was recommended as vital in the preservation of health. Exercise after meals to promote digestion was advised. The value of a full night's sleep was stressed. After an operation the patient was instructed not to touch the wound, not to expose himself to cold, not to take a bath immediately, not to eat improper food. Baths were taken in mineral waters, warmed waters, warm oil, or in vapour. Herbs and roots were prescribed as medicine, and bloodletting was resorted to. The Talmud makes a distinction between indisposition and dangerous diseases. In surgical cases artificial limbs were employed; metal plates and splints of wood were used for fractures. But medical practice, while employing methods and remedies which were the result of careful observation and experience, also employed many crude prescriptions and ridiculous methods.

If the Hebrews made any outstanding contribution to science it was in the realm of hygiene. Whether they were the discoverers of prophylaxis or received the germ idea from Egyptian science is of little consequence; in any case they excelled all other nations of antiquity in stressing the principles and practice of hygiene. In his exhaustive work on the history of medicine Dr. F. H. Garrison gives the Hebrews full credit for their splendid work in this field:

> The Hebrews attained the highest eminence among Oriental peoples in hygiene. . . . The ancient Hebrews were, in fact, the founders of prophylaxis and the high priests were true medical police. They had a definite code of ritual hygiene

> and cult-cleanliness, gradually enlarged from contact and interrelation with different civilizations. . . . Besides the physicians and high priests, who acted as public health officers, there were also professional pharmacists and professional mid-wives. . . . The principal interest in these biblical diseases lies in the remarkable efforts made to prevent them.[2]

Granting that the Hebrews availed themselves of the science of ancient Babylonia, through one source or another, why did this science not grow and develop among them as it did in Greece? What influence caused Hebrew science to remain static?

The idea of the sacred is one of the outstanding features of the religion of the Hebrews. According to this idea deities and all persons and objects associated with them were classified as sacred, in contradistinction to that which was profane or secular. Deities, shrines, altars, priests, the religious ritual and ritualistic utensils, prophetic teachings and fundamental laws, together with pictorial and written records and interpretations of them, were all sacred. Persons or objects thus set apart from ordinary or secular persons and things were endowed with the power of holiness, were of great help or harm to humanity. This divine relationship was conceived at first in low, materialistic terms, but as the religion grew to a high spiritual stature, the conception was transformed to embrace ideals of character, moral purity, and perfection. Properly, to win the favor of deity and thus be blessed with his power of holiness was the purpose of the worshiper. This required an absolutely correct technique, making use of charms, spells, sacrifices, prayers, creeds, ritual, gifts, dances and music. The feeling of dependence upon deity ran the entire gamut of the emotions of fear, awe, reverence, respect, admiration and love. A mountain upon which the deity had revealed himself through manifestations of power, was a sacred mountain and the ground was considered holy. An ark in which there was enshrined the symbol of deity was sacred. The altar of deity and its symbols were sacred. The laws, teachings, and beliefs orally imparted by the priestly or prophetic representatives of deity were sacred. The books in which these laws, teachings and religious narratives were recorded, after due time had elapsed for custom to crystallize, were considered sacred writings. There were sacred candlesticks, sacred fire, sacred or holy water, sacred days, sacred ritualistic ceremonies and services.

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[2] F. H. Garrison, *Introduction to the History of Medicine*, pp. 58-62.

> The lands in which the Semites dwelt were full from the first of sacred spots; and we have to notice that the god of a clan is also the god of a certain piece of earth, where he is supposed to dwell, which is regarded as his property, and the fertility of which is ascribed to his beneficence. In the Bible we read of sacred trees, of sacred wells, of sacred stones or mounds, and of stones or pillars which were connected with sacrifice. In various Semitic lands there are also sacred streams and sacred caves. The Semites in fact had their share of the inheritance the whole world has derived from the earliest times, of pre-historic religious sites and objects. . . . The clan gods became localized as the clans tended to acquire fixed set-

> tlements and each sacred spot was occupied by the deity of the clan who dwelt around it.[8]

The deity on the sacred mountain would reveal his will to his representatives through basic rules of conduct, directions for religious practices, military injunctions, proffered rewards or threats of punishment. The very words of deity, as thus communicated, were deemed sacred, and those to whom they were imparted were inspired, serving as living channels for deity. When these words were recorded in their narrative setting, and had been reinterpreted from age to age and revised to meet changing needs, different groups of materials were created, according to the point of view of the compilers—priestly, prophetic, etc. The oral traditions regarding the creation of the universe, and the origin of mankind and of institutions, became indelibly impressed with a religious purpose. After the centuries had enhanced the values found in them the religious records, crystallized layer upon layer, became the religious authority of the land. More and more the priestly decrees, the prophetic sermonic utterances, stories of miraculous deeds and lessons drawn from dreams were substituted for the direct mountain or bush revelations, with the stamp of approval usually added, "thus spake deity." The scientific cosmogony of the Babylonians became a vital part of Hebrew sacred records, and as such was deemed to be the ultimate word on the subject, since that word came from deity. The Hebrews canonized their religious records, deciding through custom which were divinely inspired and which were not, which were sacred and which were profane or secular, which were to constitute the fundamental spiritual authority of the nation. But this making of the canon was a long, arduous, and tedious process, lasting over three hundred years.

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[8] Allan Menzies, *History of Religion*, p. 165 f.

The supreme spiritual authority of the Jewish church was the thirty-nine books known to Christians as the Old Testament. The "Books of the Law" were first officially recognized as authoritative about 444 B.C. These are the books known as the Pentateuch: Genesis, Exodus, Leviticus, Numbers, and Deuteronomy. The "Books of the Prophets" received final approval about 200 B.C. This group consists of Joshua, Judges, I and II Samuel, I and II Kings, Isaiah, Jeremiah, Ezekiel, Hosea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Zephaniah, Haggai, Zechariah, Malachi. The "Books of the Writings," or those not included in the foregoing groups, were generally recognized by 132 B.C. These books are the Psalms, Proverbs, Job, Song of Songs, Ruth, Lamentations, Ecclesiastes, Esther, Daniel, Ezra, Nehemiah, and I and II Chronicles. Even in Jesus' day there was disagreement regarding the authority of the books of Esther, Song of Songs and Ecclesiastes, and they were not finally approved until 90 A.D. Hence, the official Old Testament, as found to-day in the Authorized and Revised versions of the Bible, was not the supreme spiritual authority in either the Jewish or Christian churches until 90 A.D. The early church fathers accepted the decisions of the rabbinical council held at Jamnia in 90 A.D., and henceforth the Old Testament was to be the supreme spiritual authority of the Christian church.

But side by side with the Old Testament there was being formed a second set of writings which were destined to be declared equally authoritative. The formation of this second or *New* Testament was an unconscious process covering approximately four hundred years. The process by which the biographies of Jesus, the records of the apostolic church, the letters of Paul, and other early Christian writings, were by custom and constant usage formed into an official, sacred body of literature, would be a revelation to many people if they knew of it. It was the use of this body of literature by Christian spiritual leaders in preaching, in worship, and in teaching, which exerted the chief influence in the formation of the New Testament canon, or list of approved books, rather than any concensus of lay opinion or majority lay vote. By 220 A.D. the following group of books had become authoritative: Matthew, Mark, Luke, John, Romans, I and II Corinthians, Galatians, Ephesians, Philippians, Colossians, I and II Thessalonians, I and II Timothy, Titus, Philemon, Acts, I Peter and I John. The minority writings that failed to receive ecclesiastical approval were: Teaching of the Twelve Apostles, Apocalypse of Peter, Shepherd of Hermas, Acts of Paul, Epistles of Clement and Barnabas, and a so-called Second Epistle of Clement.

During the next hundred years there was little or no change, the only book that was added being the Epistle to the Hebrews. Thus far East and West were agreed, but through most of the fourth and a part of the fifth centuries there was disagreement between the Eastern and Western churches regarding the early church literature. In the fourth century the Western church had records of many lists of approved writings but the earliest that agrees with the New Testament as we have it to-day, in the Authorized and Revised versions, is the one recorded in 397 A.D., and declared by the Council of Carthage to be authoritative.

The church in the Greek East, true to its speculative and philosophical interest, was undecided about a number of the writings. In certain churches II Peter and II and III John were disapproved, in others Jude and Revelation. The Christian literature put forth as Scripture was unofficially classified by leaders as universally approved, doubtful and spurious. The books of Hermas and Barnabas were quoted as Scripture by outstanding Eastern church leaders. In 363 A.D. a Council of Laodicea, representing several church districts of Asia Minor, issued a decree regarding the authority of the Old and New Testaments. The list which it put forth was apparently the first from any church council or synod, and it well typifies the mind of the Greek church. The Old Testament is given as we have it, with the addition of Baruch and the Letter of Jeremy, and Revelation is omitted from the New Testament. Augustine, in the West, laid down rules that powerfully influenced the final formulation and acceptance of what was later known as the canon. He declared that all books which the church universal approved should be canonical, that all books which were challenged should be approved if the majority of churches so decreed, and that books approved by apostolic churches should receive preference over those favored by churches not founded by apostles. Jerome gave the world his translation of the Bible, the Latin Vulgate, following Augustine's rules, and a final agreement was achieved in the first part of the fifth century. This, however, does not mean that the Christian church is a unit regarding the bounds of its Scripture even to-day. The Syrian church omits II and III John, II Peter, Jude and Revelation, and all apocryphal books. The Greek church has apocryphal books in addition to the others. The Roman church reopened the question at the Council of Trent, April 8, 1546, and added apocryphal books. The standard King James version and the Revised version—which is to say the Bible of the Protestant churches—omit apocryphal books.

Since the Old and New Testaments have been not only the guiding rule of faith and practice for morals, religion, theology, and tradition, but also have been put forth as authority against the principles and hypotheses of science, it has been deemed wise to state the nature of this authority and something of the history of its formulation and use.

In the supreme interest of an emerging monotheistic religion the Hebrew religious teachers and authors built their science upon Babylonian foundations, divesting it, however, of many polytheistic, magical and superstitious elements. Their growing religious literature incorporated oral traditions and the religious records of the times. The result was that in these writings, which time and custom finally decreed to be sacred, the scientific traditions of the Babylonians were incorporated, completely colored, however, by the Hebrew religious purpose.

The Old Testament was the Bible of the early Christian church, while the New Testament was yet in the making. Jesus had set the example through his constant use of the Old Testament in his private devotions and in support of his public teachings. The apostle Paul had the same high regard for the Jewish Scriptures, although he wrote his missionary letters in Greek. As a result the reading and exposition of these Scriptures formed a very vital part of the early church service of worship. Personal accounts of the deeds and sayings of Jesus were also made a part of the service.

At first the Old Testament was ultimate authority, outranking the materials of the embryo New Testament. Allegory was the fanciful method employed to discover a complete statement of Christianity in the Old Testament. The old Jewish idea that every part of their Scriptures possessed spiritual significance and religious meaning was taken over by the first Christians, and this conviction later was applied also to the New Testament.

Thus, when the new faith of Christianity separated itself from the religion of the orthodox Hebrews, the idea of authority residing in sacred writings was adopted by the Christian leaders. The Hebrew Scriptures became the divinely inspired writings of the new faith, which meant that the Babylonian science and world view, as religiously interpreted by the Hebrew writers and accepted by the Jewish nation, became the accepted science and world view of the Christian church. As the Old Testament had become the last word of authority regarding nature and world origins for the Hebrews, so did the Christians accept the same authority, a divine textbook, not only for religion and character building but also for science in the Græco-Roman world. This attitude was to create a most unfavorable reaction against the Greek scientific discoveries and the Roman scientific adaptations. For succeeding ages the story of the Christian church is very largely an account of the ecclesiastical control of science in the interests of formal religion.

CHAPTER III

ECCLESIASTICAL CONTROL OF SCIENCE

THE early Christian church was an emergency school to prepare for life in another world. The textbooks were the Old Testament and the materials of the New Testament then in the process of formation. The theology of the Hebrews, the teachings of Jesus and the interpretations of Paul constituted the basis of Christian education. But the content of this instruction was ever highly colored by a controlling belief in the speedy second coming of Jesus, which would be accompanied by the reward of the faithful Christians, the punishment of the persecuting pagans, the fall of the Roman Empire and the end of the present world. The first Christians were simply pilgrims, enduring a brief existence in a wicked and doomed world, awaiting a summons to be transported as citizens to a heavenly kingdom, where their reward would be life eternal.

Christianity came into a world that was at a very low ebb morally and spiritually. Slavery was the basis of civilization, with all its demoralizing influences. The plays in the theaters, and the gladiatorial contests in the amphitheaters, were exceedingly debasing. Divorce, infanticide and vice were undermining the family. Learning and education were purely intellectual, and were not usually associated with morals. The high period of creative philosophical and scientific learning had passed. The curriculum of the schools of the Roman Empire included the observance of festivals, accompanied by many gross practices, as well as the study of the lives of the pagan deities, treating in full their immoral escapades. Moreover the personal lives of many of the teacher-philosophers were not unimpeachable. Into such a civilization came the Christian church with its moral and spiritual message.

Scarcely had the Christians been distinguished from the Israelites throughout the Roman Empire when they were seriously misunderstood. Characterized as atheists because of their abhorrence of the pagan deities, as traitors for their refusal to participate in sacrifices which acknowledged Cæsar as Lord, as vicious because of their secret meetings, as antisocial in keeping aloof from other groups and proclaiming a kingdom that would overthrow Rome, they gained a reputation with their pagan neighbors which easily crystallized into contempt and resulted in persecution.

The Christians, moreover, had just as low an opinion of the pagans as had the pagans of the followers of Jesus. They roundly condemned the Roman Empire for polytheism, idolatry, blasphemy, cruelty and persecution. They denounced the philosophers because of their criticism of Christianity, their free-thought tendencies that led to heresies, and their moral shortcomings. The depreciation of the Christian Scriptures by philosophers led to a counter-attack upon philosophy by church leaders.

Christianity had been recruited largely from the poorer, unintellectual masses of the people, and its adherents did not appreciate or evaluate very highly the need of philosophical, scientific, or artistic culture. There was, however, a considerable minority of Christians of high intelligence, who understood the ancient learning and desired Christianity to be expressed in intellectually convincing terms. But pagan science, philosophy and literature were so intermingled as to prevent any sharp differentiation or choice on the part of Christians.

It was inevitable that the church would be forced to take a stand regarding the current non-Christian education, science and philosophy. Its position with reference to non-Christian learning was just an important phase of its total attitude toward the Roman Empire, an attitude variable and flexible at first but finally to become very fixed and uniform.

The Greek mind was essentially speculative and philosophical, interested in exploring theories and hypotheses and achieving results in the realm of abstract science. It was natural, therefore, that the Greek Christians, from the beginning, were leaders in favoring non-Christian learning. They wanted a system of belief that was well organized and complete, and in the first Christian schools in the East the Greek leaders sought to cast Christian belief in the thought molds of Greek scientific and philosophic learning. These leaders in the Greek Christian church were for the most part teachers and philosophers, and their interest in the non-Christian learning as applied to the Christian Gospel is summarized in the statement that "pagan philosophy was a pedagogue to bring the world to Christ."

In the Greek Christian school at Alexandria the teachers sought to discover points of contact between and to harmonize, the gospel and science and philosophy. They believed that the world was round, and accepted the positions of the non-Christian thinkers.

The famous teacher Clement of this Alexandrian school said:

> With regard to the value of human knowledge I call him truly learned who brings everything to bear on the truth, so that from geometry, and music, and grammar, and philosophy, itself, culling what is useful, he guards the faith against assault. . . . The Mosaic law and heathen philosophy do not stand in direct opposition to each other, but are related like fragments of a single truth, like pieces, as it were, of a shattered whole. . . . Both prepared the way, but in a different manner, for Christianity. . . . Plato was Moses Atticized.

Basil, the Great, another Eastern leader, indicates that a judicious choice must be made between the edifying and the degrading in the works of non-Christian authors:

> So we, if wise, shall take from heathen books whatever benefits us and is allied to the truth and shall pass the rest. . . . Moses cultivated his intelligence by studying the science of the Egyptians and Daniel adorned his mind with that of the Chaldeans. . . . There is a choice to be made among pagan authors. . . . The reading of poets, historians and orators is very useful.

Other Greek leaders held similar views. The famous preacher Chrysostom stated the issue thus: "Which is to gain the day: science or the soul? If you can unite both advantages, do so by all means: but if not, choose the most precious." Justin Martyr, formerly a Greek teacher, made the bold assertion that Socrates and Plato were Christians and that Greek philosophy was allied to Christian teachings. He continued to wear the distinctive philosopher's garb. The most brilliant of them all, the mighty Origen, who did more than any other leader to provide a systematic formulation of Christian belief, endeavored to unite the Christian gospel with Greek science and philosophy.

The Roman mind, on the other hand, was fundamentally practical and utilitarian, eager to apply theories and hypotheses to useful inventions and works of engineering and architecture, thus achieving results in the field of concrete or applied science. The leaders of the church of the West were lawyers, orators, teachers of public speaking, and rhetoricians. They had been interested in public life, in oratory, legislation, politics and government, and they carried with them into Christianity the desire to build a powerful church organization and administrative system, with all the practical devices and methods that would speedily construct a great spiritual empire, after the analogy of the material empire built by Rome. They took with them the atmosphere of the Roman Forum rather than of the Greek Academy—the atmosphere of law, order, authority and organization, not that of philosophy, speculation and science. They were not concerned with profound discussions in philosophy or abstract speculations on scientific theories. They shared the general Roman attitude toward Greek science, and when they became Christians they retained their lack of interest in Greek learning. The church of the West might have summarized its spirit in the statement that "Roman government was an organization to bring the world to Christ."

Instead of the Greek note of freedom there is the Roman note of authority. St. Augustine well epitomizes it in the saying, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human understanding." Augustine half-heartedly believed in the Greek theory of the spherical form of the earth, but such a belief was of no vital moment to him: "What concern is it to me whether the heavens as a sphere enclose the earth in the middle of the world or overhang it on either side. . . . It is impossible that there should be inhabitants on the other side of the earth, since no such race is recorded in Scripture among the descendants of Adam." He seeks God's pardon for once having appreciated the writings of the Roman master poet, Virgil. He expresses the conclusion of the whole matter in the words, "It is the ignorant who gain possession of heaven."

The leaders of the Roman church in the West saw in Greek speculation, philosophy and science the seed of heresy, which was also an important reason for the prohibition of pagan learning. Writes Tertullian, a Roman lawyer, highly educated in Greek culture:

> What resemblance is there between a philosopher and a Christian, between a disciple of Greece and a disciple of heaven? What indeed has Athens to do with Jerusalem? What concord is there between the Academy and the Church? What between heretics and Christians? Away with all attempts to produce a mottled Christianity of Stoic, Platonic, and dialectic composition. . . . For us we have no need for curiosity, after Jesus Christ, nor for investigation, after the Gospel.

The Western note of impatience concerning matters that appear impracticable and not of direct value is revealed in a remark of Ambrose: "To discuss the nature and position of the earth does not help us in our hope of the life to come." Even the church historian Eusebius affirms the same viewpoint: "It is not through ignorance, but through contempt of such useless labor that we think little of these matters and turn our souls to better things." Pseudo-Justinus concludes with a statement regarding the nature and achievements of the gospel: "The power of the Logos does not produce poets or philosophers, or clever rhetors, but confers immortality."

Correct style, diction, grammar and rhetoric were matters of great importance to the educational leaders of the Græco-Roman world. When these non-Christian teachers analyzed the rather bare, unpretentious and vernacular style of a number of the books of the Christian Scriptures they heaped scorn and abuse upon them for their crudities and cheapness of form. None other than Gregory the Great replied to such attacks when he gently rebuked a church leader who taught literature and also employed the rules of grammar in the interpretation of Scripture. Gregory's naïve opinion was yet most logical on the basis of his conception of Scripture. He said: "My brother, I have learnt what I cannot think of without pain and shame, that you have thought proper to teach Grammar (Literature). Learn then how sad and awful a thing it is that a bishop should deal with things of which even a layman ought to be ignorant." And officially it was proclaimed that the Divine Word was independent of grammatical rules: "I am strongly of the opinion that it is an indignity that the words of the oracle of Heaven should be restrained by the rules of Donatus."

The belief was gaining rapid ground that all education that was essential was included in the Scriptures, and this view was expressed most admirably in the *Apostolic Constitutions,* a Christian writing of the first part of the fourth century:

> Abstain from all heathen books, for if thou wilt explore history, thou hast the Books of the Kings; or seekest thou for words of wisdom and eloquence, thou hast the Prophets, Job, and the Book of Proverbs. . . . Or dost thou long for tuneful strains, thou hast the Psalms; or to explore the origin of things, thou hast the Book of Genesis. Wherefore abstain scrupulously from all strange and devilish books.

The great literary opponent of Christianity, Celsus, states what appears to him to be the church's attitude toward prospective members: "Let no one come to us who has been educated, or who is wise or prudent, for such qualifications are deemed evil by us; but if there be any ignorant, or uncultivated, or unintelligent, or foolish person, let him come with confidence." The advice which he imagines the church leaders giving to members is in the same strain: "Do not examine, but believe. Thy faith will save thee. . . . The wisdom of the world is an evil thing, but folly is a good thing. . . . See that none of you lay hold of knowledge. Knowledge is an evil. . . . Knowledge causes men to lose their soundness of mind; they perish through wisdom." Many Christians eagerly desiring to keep themselves unspotted from the world deliberately shut out of their lives all aspects of Græco-Roman culture, science and education.

Gradually the tide swept across the entire Christian world. Those who had been enthusiastic for non-

Christian learning lost most of their zeal, their change of attitude being expressed in the words of Chrysostom: "I have long ago laid aside such follies, for one cannot spend all one's life in child's play." Augustine, whose monumental work on *The City of God* defended Christianity against the charge that the fall of the Roman Empire was due to the casting aside of the worship and faith in the gods, included in that work the following comment on Roman medical science: "Medical men who are called anatomists . . . with a cruel zeal for science have dissected the bodies of the dead, and sometimes of sick persons, who have died under their knives, and have inhumanly pried into the secrets of the human body to learn the nature of disease and its exact seat, and how it might be cured." Augustine's influence at the church council at Carthage in 401 secured the passage of a decree forbidding church officials to read non-Christian books.

As a result Christianity viewed the Roman world as a "crooked generation," and the era as "the present evil age." The Christian converts were to keep themselves unspotted from the world, and hence were to avoid the science of the Roman world as a part of the pagan civilization. Attacks on pagan philosophers, scientists and their writings naturally followed. The opposition of the church was directed against everything pagan. The cruel persecutions which Christians had suffered in the Empire precluded feelings of conciliation on their part. Yet the philosophical spirit of trenchant criticism of the traditional pagan religion and of Christianity itself still lived. Tending as it did to treat unreservedly all phases of religious belief it was a most disturbing factor, and led later to many heresies. The Western church had every reason to fear the transference of pagan philosophical speculation into the field of Christian theology. The church's leaders turned definitely away from culture, science and intellectuality as a means for the salvation of the world, stressing instead morality, theology and discipline.

Relying on Augustine's definition of authority the church fathers came to think that the Scriptures contained all knowledge that was necessary. The Christian inheritance from the Hebrews was interpreted and applied most literally. The maxim employed by Tertullian, Augustine, and the other leaders was, "The Bible contains the sum and substance of all knowledge, useful or possible to man." The authority of the Scriptures was not limited to the moral and spiritual realm but covered also the cosmic views of the Bible which thus became the authoritative scientific views for all Christians. The stories in Genesis as to the origin of the world, of man, of evil, and of languages were set forth as the final word. This view of the ultimate authority of religion to control if not suppress science was a matter of slow but inevitable growth. Its complete development resulted in the theological attitude of mind which became fully exemplified in the Middle Ages. The science that remained did not conflict with the theology of the church. Creative science was practically dead, or existed in a state of coma in the monasteries; applied science managed to live, but not a very normal life.

Christianity therefore was one of the contributing agencies that controlled and suppressed ancient science and prepared the way for the Dark Ages. The immorality of the age, the attacks of the illiterate barbarians, the lack of interest of the Romans in abstract science and creative learning, the critical attitude of the pagan philosophers and teachers, the decay of ancient faiths and ethics, the fact that early Christian converts were prevailingly unintellectual, added to the opposition of the church fathers, caused ancient science to fade out of the picture.

The Middle Ages cover a period from the fifth to the fifteenth centuries, with the first three designated as the Dark Ages. In the West the schools of ancient science lasted until the early part of the sixth century, and they continued in a decadent state in the East, at Constantinople, for many more years. But the mind of the Middle Ages controlled Europe, which meant in general a mild perpetuation of such science as seemed to accord with Scripture and a suppression of creative scientific research.

The Scriptures, theological tradition, and council decrees became the supreme authority in matters of education and science in the Middle Ages. The feudal lords were interested in maintaining their political and social security. The peasants were busily engaged in tilling the soil, trying to earn enough to pay the obligations due to the nobles and the church under the manorial system. The knights spent their time in practicing the ceremonies of military and social chivalry. As a consequence learning was relegated to the clergy, especially to the monks, and education was primarily for the purpose of training church leaders for the future. The services were in the Latin language and the church officially made daily reading of religious books obligatory on the part of the clergy. Latin however was fast becoming a dead language as far as the laity were concerned, and the ungrammatical Latin usage developed into the vernacular Italian, French and Spanish. Books were very scarce and costly, and were usually the property of royalty, the wealthy, and religious officials. Many of the ancient classics were destroyed or lost, especially in the West, and what were available were in the Greek and Latin languages and but few could read them, even among the teachers of Europe, the clergy.

Asceticism arose as one of the outstanding forces and influences in the Middle Ages, expressed through the institution of monasticism. The growth of the ideal of flight from a lost world to save one's own soul is due to a number of factors. Instead of coming to a violent end with the inauguration of a new heavenly and new earthly order the present evil world still existed and grew worse. There was the idea that the flesh was the foe of the spirit, and should be subjugated by rigorous acts of self-discipline, self-denial and self-sacrifice. There were heresies attacking almost every phase of Christian belief. Many Christian converts became grievous backsliders. The church was becoming a vast political system, with all of the attendant vices, and it seemed hopeless to save a corrupt world through such a tainted organization. Added to all these factors was the craving of many devout Christians for solitude, contemplation, and solitary communion with God. In earlier centuries there had been flights to catacombs and to desert waste places during times of persecution, and now that the reign of terror was over there was a longing for a dynamic idealism, a moral equivalent of the martyr spirit. These were basic influences in establishing the practice of ascetic virtues in the church of the Middle Ages.

At first there was the simple practice of these virtues in the home itself: celibacy, prayer, contemplation and simplicity of life in dress, speech and habits. But the pressure of the world and the atmosphere of evil were so strong that many Christians of ascetic bent literally left the world of civilization to wander in desert, wilderness, and mountain, or to become anchored in a cell, or on top of a pillar, or later to unite with a group of like-minded Christians in a monastery or convent.

The social instincts of these Christian wanderers in search of soul salvation were too strong to be repressed, and soon a simple association was formed, then a more firmly knit contemplative order, and finally a most rigid system. The ideal of saving one's soul by leaving the world was still maintained, and the practice of virtues was instilled by the vows of chastity, poverty and obedience. The Greek or Eastern ascetic made a rather negative contribution to the world through his self-centered life of mystic reverie, while the Roman or Western ascetic unconsciously made a vital and positive contribution as a practical man of affairs in rebuilding a chaotic world civilization; the Eastern attitude grew out of the Greek inclination to mysticism and reflection, while the Western viewpoint of the Roman ascetic expressed itself in a program of practical organization and administration.

The Western monk was in reality the applied scientist of the Middle Ages. As sanitary engineer he became the drainer of swamps; as scientific agriculturist he taught Europe better methods of farming; as scholar he preserved and kept the records of the learning of the past and of his own day and transcribed, illustrated and bound books; as physician he built hospices and relief shelters and provided medical aid in case of need, thus giving Europe its first hotels, hospitals and community centers; as teacher he conducted the professional and lay schools of the Middle Ages, making a wonderful contribution toward rebuilding a civilization almost wrecked by barbarians.

The content of the science and scientific work of the period was exceedingly crude and circumscribed, when we compare it with that of the golden days of Greece, yet science did not completely die out. It lived in a theological strait-jacket, marking time not making progress.

Just how did the Christian church evolve methods and means of officially suppressing heretical beliefs?

Ecclesiastical control of Christians began very simply in the days of the New Testament apostles. The primitive leaders recognized the ever-present urge of the ex-heathen to backslide, and three sins were listed as making restoration impossible; paganism, homicide, and immorality. Gradually, however, a system of prolonged penance, leading to restoration, was evolved, and the offender was gradually readmitted into the privileges of the church. Slowly the custom arose whereby the faithful church members made regular confession of their sins to the local priest. At first this was optional, but it became obligatory in 1215, as decreed by the Fourth Lateran Council. From the earliest days of Christianity there were "courts" in the churches to consider grievances; at first the congregation, then special members, and finally the bishop was the community judge. Thus arose the Christian courts and the canon or ecclesiastical law. The penalties were excommunication, which meant exile from the neighborhood, and later condemnation to hard penance in a monastery, the payment of severe fines, and scourging, a form of criminal punishment. Heresy was one of the most terrible crimes in the minds of clergy and laity. The early heresies of the church pertained to theological disputes too abstruse for the lay mind to grasp, and hence the heretics were usually clergy. The church court did not invent an ecclesiastical legal procedure but adopted that of the harsh Roman law. Thus did the system of the Inquisition or heresy suppression courts arise, the descendant of the simple idea of penance.

The investigation and punishment of heresy had not been authoritatively standardized by the church in the early Middle Ages. The rise of two religious sects, the Cathari and the Waldenses, which differed very considerably in belief and practice from the established Church, hastened the organization of inquisition suppression. A synod held at Toulouse, France, in 1229, authorized the inauguration of a special institution for the discovery, examination, and suppression of such heresies. The plan of procedure was to delegate a priest and several laymen in each parish to bring heretics before the bishop. In 1233 the institution was launched, with the procedure greatly changed. The Dominican order was given complete control of heresy-hunting and punishment. This order of preaching friars had been founded at Toulouse in 1215 to overcome the Albigenses (Cathari) by saintly virtues and by argument from Scriptures and dogma. The legal system now put into its hands was the rigorous Roman criminal law transferred to ecclesiastical offenses; the accused was deemed guilty until he proved his innocence, which he had little chance to do. Third degree methods of cross-questioning, torture, fines, confiscation of property, even the death penalty, were measures taken to suppress what was considered the most awful and terrible of crimes, heresy. Public sentiment did not lag behind that of the clergy, and the secular rulers rather stimulated the work of the Inquisition. The accused was allowed no witnesses in his behalf. The church technically and theoretically did not inflict punishment, but transferred the accused, when condemned, to the custody of the State for the execution of penalties. But the church tacitly gave the authority and power for such punishment in its official decrees.

The Council of Toulouse, in 1119, decreed "that they [the heretics, who rejected the sacraments] be punished by the temporal power." The Lateran Council (1139) presided over by Innocent II condemned heretics to be "imprisoned by the Catholic princes," and their goods to be confiscated. In 1198 Innocent III asked "the princes and the people" to oppose heresy with the "material sword."

> The papacy, under the most severe penalties, commanded the civil power to rid it of heresies, and the civil power acquitted itself of the task by executing the heretics, most often by fire. . . . Whoever was denounced as a heretic by two witnesses was found guilty of heresy. Criminals, who, by the common law, were not to act as witnesses, were admitted to denounce heretics; and their denunciations were believed. The accused learned from his judges what charges were brought against him; he knew them only incompletely through a garbled report. Moreover, he was not brought face to face with his accusers; their names were kept secret. He was authorized merely to give a list of his mortal enemies; and the testimony of any denouncers whose names were on this list was rejected. He was obliged to defend himself, and could not com-

> mit his case to any advocate. At length, from the time of Innocent IV. (*Constitution Ad extirpanda,* 1252), he was subjected to torture to oblige him to admit his guilt. When the victim, overcome by suffering, made his avowals, he was led into a neighboring room, and there declared that he admitted his guilt, "of his own full accord without having been constrained." During the first years following its establishment, the infliction of torture was a task reserved for the laity. But Popes Alexander IV. (1260) and Urban IV. (1262) authorized ecclesiastics to fill the rôle of torturers.[1]

Heresies, or unauthorized interpretations of Christianity, crept early into the Christian church, especially in the speculative and philosophical East. After the edicts of toleration had been promulgated in 311 and 313 A.D., the period of persecution from without being safely past and the church politically established by Constantine the Great, fearful persecutions arose from within. Differences of opinion had as their background the influence of Judaism on the church, the attempt to correlate Greek philosophy with Christianity, the reconciliation of Persian Zoroastrianism with the Christian faith. Disputes had to do with such matters as proper fasting, the correct day on which to observe Easter, the validity of baptism by heretics, the problem of the backslider, and theological speculations about the nature of God, Christ, the Holy Spirit and free will. So furious were these discussions that general church councils were called to try the heretics and settle the issues, at Nicæa in 325 A.D., at Constantinople in 381, at Ephesus in 435, at Chalcedon in 451, at Constantinople in 553; and in addition to the major controversies thus dealt with there were scores of minor disputes and upheavals. Heretics whose opinions did not coincide with those of the majority of the council delegates were generally condemned, excommunicated and exiled.

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[1] André Lagarde, *The Latin Church in the Middle Ages,* pp. 496-501, 503-504.

Following the era of early heresies Europe was plunged into the barbarian Dark Ages and the heresies subsided. The church was engaged in rebuilding a fallen civilization and converting the barbarians, meanwhile incorporating many barbarian customs which it attempted to transform. The Western monks were now rendering their great service to Europe. From the standpoint of learning and education the Dark Ages were black and gloomy indeed, save in Ireland and in a minor degree in the Byzantine empire.

In attempting to reproduce and perpetuate the Roman Empire the church in the West evolved a splendid practical organization and administration. The Roman church had ever fought Greek science and philosophy as tending toward heresy and trouble. The matter, however, came to an ultimate crisis in 1054, whereupon the Roman and Greek churches excommunicated each other. Many were the inherent differences in theology and practice. The Roman church, the one unified power in all Europe, now freed from the Eastern church, went forward humiliating kings who defied its power and keeping a watchful eye upon all incipient attempts in the realm of science to contradict the established faith.

Theologians and ecclesiastics almost uniformly opposed every advance in science as heretical and

> un-Christian, and there thus began the conflict between religion and science which troubled the Church for many a generation. . . . It is commonly spoken of as a conflict between religion and science. As a matter of fact it was rather a conflict between two diverse sciences, the one unfortunately supported by the Church. . . . Had the Church in the beginning frankly recognized that the Bible and the fathers teach an antiquated world-view, and frankly put itself on the side of scientific observation and experiment, the whole religious situation, both Catholic and Protestant, would be to-day far other than it is.[2]

The church was really pitting the science of the Babylonians and the Egyptians, and certain basic views of Ptolemy, Galen and Aristotle, against the creative science of antiquity. It was supporting obsolete scientific ideas of former days as literal, sacred truth against the discoveries of science in the natural world of that time. It was upholding a science mixed with magic and speculation, as compared with a science that made its discoveries by observation and experimentation with the best instruments that it had at its command. The church's science was an incidental handmaid of theology, as compared with a science that was striving to become entirely independent of theology. It was the science of a small universe, a tiny earth of comparatively recent origin, created outright, a flat, stationary earth in which God worked by miraculous intervention and in which there were opposing evil spirits. All this antiquated science was defended as sacred truth.

[2] A. C. McGiffert, *The Rise of Modern Religious Ideas*, p. 34.

> The history of European science in the Middle Ages is twofold. On the one hand it is concerned with the *recovery and assimilation of the science of antiquity,* little known at first and only gradually brought into the West, to some extent as enlarged by the Arabs, in the course of the twelfth and thirteenth centuries; while on the other hand, it has to take account of the advance of knowledge by the processes of observation and experiment in Western Europe. The first phase deals primarily with translation from the Arabic and the Greek, in Spain, Sicily, North Africa, and the East, as a preliminary to the full assimilation of these successive increments of ancient learning and the Arabic additions thereto. The second, more obscure, has to trace the extension of knowledge by such means as the observation of plants and animals, especially dogs, hawks, geographical exploration and the growth of the experimental habit.[3]

The Moslems, in connection with the holy crusading wars that unified and stirred all Europe, unconsciously broadened the outlook of Western Christendom and prepared the way for the return of creative science. The Arabs who swept across Asia and Africa into Europe were much interested in Greek science, notwithstanding such an example of destructiveness as the burning of the famous and priceless library of manuscripts at Alexandria. On the whole Mohammedanism was more tolerant of science than was contemporary Christianity.

Just seven years after the death of Mohammed the zealous Arabs, possessed by the spirit of their new faith, swept all opposition before them in their efforts to convert, levy tribute upon, or wipe out the non-Mohammedans. In 641 A.D. they conquered Alexandria, the headquarters of the scientific world. Successive campaigns led to the subjugation of portions of Mesopotamia, India, Asia Minor, North Africa and Spain. The first hundred years were years of conquest, and many depradations occurred that meant loss to civilization and science. When the library at Alexandria was on the verge of annihilation the Arab decree was: "If the books agree with the Koran, the Word of God, they are useless, and need not be preserved; if they disagree with it, they are pernicious. Let them be destroyed." But although the Arabs were destroyers when on the march, when they settled down and developed a life of peace they fostered the arts and sciences. From the banished Nestorian Christians in Assyria and Persia they had received translations of many scientific works of the ancient Greeks. From the Jews in Mesopotamia and Syria they learned about things medical. From the Hindus in India they acquired knowledge of mathematics and astronomy. At Alexandria in Egypt they came in contact with the general science of the Greeks as modified by the Alexandrian school. The destroying spirit which they manifested in the first century of their conquest gave place to the spirit of the builder. Schools and colleges were established in various parts of Asia, Africa and Europe: at Cairo, Bagdad, Salerno, Cordova, Meraga, and elsewhere. The Arabs were keenly interested in astronomy, mathematics, physics, medicine, surgery, botany, pharmacy, and chemistry. Unfortunately they mingled astrology and alchemy with their astronomy and chemistry, and they made no outstanding contribution to pure science in the discovery of scientific laws and principles, yet they performed a magnificent service to humanity by renewing a world interest in science. They unearthed and assembled Greek scientific works that had been scattered when Justinian closed the Greek schools in 529, developed the ancient science in no small measure, and extended greatly the inventions and discoveries of applied science.

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[3] C. H. Haskins, *Studies in the History of Mediæval Science,* Preface.

Manuscripts were collected, translated, and organized. Materials were assembled which formed the basis for observation and experiment, the Arabs revealing a splendid spirit of toleration and freedom of inquiry. They improved upon the Greeks, who had failed when they injected speculation into their science, by relying on observation and experiment rather than speculation. Scientific instruments were improved, and practical measures resulted in such important inventions as the Cordovan and Morocco leather and Toledo and Damascus steel blades, and in such architectural achievements as the magnificent castles and palaces of the Moors in Granada and Seville.

> Arab science must, therefore, be regarded as the most important bond of continuity between the science of antiquity and that of modern times. The services of the Jews may also be mentioned, who were the chief interpreters to Europe of the Arab learning. They seem to have been second only to the Moors of Spain in their cultivation of natural science. . . . The influence of Arab culture upon the intellectual life of Christendom was more lasting than its influence upon the life of Islam. . . . Arab science was, therefore, one of

> the most important cultural influences during the later Middle Ages.[4]

Arab science did not make much impression on Europe, in general, in the period of Arab glory. Not until the dawn of the Renaissance do we meet with the practical use of ancient science recovered through Arabic mediation. The church was officially opposed to Mohammedanism and all that was affiliated with it. It was a conflict of Christ and Mohammed, the Bible and the Koran, Islam and Christianity, and of course between the ecclesiastically controlled science of the Christian world and the Græco-Arabic science. But the seeds that had been planted in southern Italy, Spain, Africa and Syria, the seeds that were also implanted in the hearts of the returning crusaders of the church, were to bear much fruit in the era of the Renaissance. Arab science suffered a death blow in Spain when the Moors were expelled, and in the Near East it was paralyzed when the barbarous Turks came into control of Islam. But its influence lived on; the Arabs had made a great contribution to the cause of science for all time.

While Western Europe, in the Middle Ages, was in the ecclesiastical strait-jacket in respect to matters intellectual and scientific, the Roman Empire continued to exist as the Eastern or Byzantine Empire, with its capital at Constantinople. From the fourth to the tenth centuries this Empire served nobly as a strong bulwark for Europe against the hordes of marauding Asiatic barbarians, and all the while the ancient Græco-Roman culture, civilization, classics, and science lived in the East while in the West they almost perished. During the Fourth Crusade, in 1204, the Latin crusaders captured Constantinople, and for fifty years the Greek East was subject to the Latin West. At this time the writings of Aristotle and other Greeks, as well as Roman writings, came to be known in the West. But the Roman and Greek churches had formally and mutually entered upon a schism and this crusading domination did not improve their relationship.

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[4] W. C. Curtis, *Science and Human Affairs*, p. 59.

> The semibarbarous Latins were amazed at the sight of the beautiful city [Constantinople], which had survived all the devastation of the Dark Ages and lay before their eyes in all its splendour. . . . There were two sieges, in 1203 and 1204; and on April 13th the imperial city was abandoned to the brutality of the crusaders. Its wealth was pillaged, the art of antiquity perished, the altars and shrines were not spared, and piety throughout Europe was stimulated by gifts of relics ravished from the churches of the Greeks. This amazing crime was followed by the establishment of the short-lived Latin Empire in Constantinople. . . . Henceforward distrust of Latins became rooted in the Greek mind; and Western Christianity appeared more dangerous than Islam itself. Co-operation was henceforth impossible and the empire of Turkey in Europe, though deferred for more than two centuries, became inevitable.[5]

In Constantinople the learning of the ancient world was authoritatively "preserved" but there was no progress or advance beyond what had been done by the Græco-Roman masters. When the Turks finally cap-

[5] E. J. Foakes-Jackson, *Introduction to the History of Christianity*, pp. 159 f.

tured the city, in 1453, the migration of Greek scholars to Western Europe and the dispersion of the manuscripts which had been kept in the libraries of Constantinople became a source of stimulus to the revival of learning and culture. To Rome, Siena and Florence came these Greeks, after the fall of Constantinople. Many indeed had come before that crisis. "Between 1420 and 1430 George of Trapezium, Theodore Gaza, and John Argyropylus had taken up their residence in Italy; and, after the capture, there came a multitude, represented by such men as Constantine Lascaris, Demetrius Chalkondylas, and Emanuel Moschopylus."[6]

After the chaotic ages of barbarian conflict the era of peace and political reorganization afforded time for the cultivation of educational and scientific interests. The outstanding leader who realized the need of education and was in a position to make some headway against the high tide of ignorance was Charlemagne, who instituted what is sometimes called the Carolingian renaissance. His ideal was to provide elementary education for all, and the opportunity for higher education for those who wished it. He planned a system which included village schools for elementary work, with parish priests as teachers, higher monastic and cathedral schools, and above these, the School of the Palace. The higher schools had practically a uniform curriculum. There was the *trivium,* which included rhetoric, grammar and dialectic or philosophy; and the *quadrivium,* which had as its subjects music, geometry, arithmetic and astronomy. But owing to Charlemagne's death, and to wars and invasions, this system was never fully put into practice. There was nothing in it that would in any way conflict with the approved learning of the church. The Scriptures and the doctrines of Galen, Ptolemy and Aristotle were to remain supreme. Of pure creative science there was none, although there was some activity in applied science, throughout the entire period.

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[6] J. F. Hurst, *History of the Christian Church,* p. 209.

When the church had become well organized in the West the bishops established schools in affiliation with the cathedrals, to train the future clergy and also to provide opportunities for advanced training for the clergy in service. These cathedral schools under the control of the bishops were directed by a *scholasticus*, or teacher. The curriculum at first included reading and writing and later grammar. As elementary schools were established the cathedral and monastic schools became the secondary schools of the early Middle Ages, and so remained for six hundred years, the "seven liberal arts" comprising the curriculum.

The scientific knowledge of the schools was exceedingly elementary and limited. It included a smattering of geography, astrological astronomy, and some acquaintance with plant and animal life. "In astronomy, the chief purpose of the instruction was to explain the seasons, and the motions of the planets, to set forth the wonders of the visible creation, and to enable the priests to fix the time of Easter and all other festivals and holy days, and to announce to the congregation the proper celebration of them."[7] Theology was the one professional study of the early Middle Ages. The influence of the Moslem science and the spirit of inquiry brought back by the returning crusaders stimulated the church teachers to devise a new method of theological study, the use of philosophical speculation in the systematizing of church doctrines. Thus arose scholasticism and the system of belief known as scholastic theology, having its origin particularly in the cathedral schools.

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[7] E. P. Cubberly, *The History of Education*, p. 160.

In short, science was effectively controlled by the church during the Middle Ages, and nothing that opposed the Old and New Testaments, in any realm of learning, was countenanced. The suppression of the creative Greek science, accomplished by the later church fathers, was facilitated by the final dissolution of the pagan schools of learning. The astronomy of Ptolemy, the medicine of Galen and the logic of Aristotle were the scientific authorities, harmonized, of course, with the Bible. But much of the learning of the Middle Ages expressed itself in philosophical and theological disputation, and out of this the heresies for the most part grew.

One type of ancient science, however, was popular in this period. The old Babylonian, Egyptian and Hebrew interest in astrology and alchemy lived again. Signs, wonders and miracles dominated the fearful mind of the Middle Ages. Yet along with all this a number of practical inventions are to be noted as products of the period. Glass was used in cathedral windows; the organ was first installed in churches, and bells in the towers; striking clocks with wheels and weights were employed in monasteries. Windmills came into use. Venetian glass, compasses, gunpowder and lenses were invented or improved. All these were mechanical inventions of applied, not pure, science.

Since the pyramids, temples, palaces, theaters, aqueducts, amphitheaters and fortresses of antiquity are rightly considered as achievements of engineering science as well as of art, so we may list the mighty

Gothic cathedrals of the Middle Ages as a great scientific achievement.

> In one form of applied science the twelfth century stands in the forefront, namely in architecture. . . . In this the twelfth century stands out as the culminating period of Romanesque, and the beginning of the Gothic style, the latter being not only an artistic achievement of the highest significance, but an engineering feat as well, in the measure of strain and stress and in the skillful use of materials and the balance and harmony of the whole. . . . This knowledge was handed down in practice rather than in any theoretical manuals.[8]

The Gothic cathedral is the greatest and noblest achievement of the late Middle Ages and is the symbolic expression of that era. The superb examples in Paris, Chartres, Reims, Amiens, Rouen, and in other lands, bespeak an architectural skill worthy to rank with the best that the Egyptians, the Greeks and the Romans achieved. And they were built in the true spirit of science by architects, builders and workmen who thought more of their work than they did of any personal consideration, with the result that their names in most cases are unknown.

The outstanding scientist of the Middle Ages was Roger Bacon, an English Franciscan friar. Breaking away from Aristotelian logic and philosophy and theological tradition, the accepted bases for the study and advancement of truth, Bacon vigorously substituted the method of reason, which he applied in the observation of nature and in laboratory experiments. He took mathematics as the basic science in the measurement and interpretation of other sciences. His range of interest covered the fields of astronomy, physics, mathematics, geography, chemistry and medicine. Familiar with Greek, Roman and Arabic science, he described, discovered, and foretold many uses of applied science far in advance of his day. Yet in spite of his scientific point of view he retained many of the ancient and medieval ideas in alchemy. His supreme contribution was his insistence upon the scientific method, rather than his actual achievements in discovery.

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[8] C. H. Haskins, *The Renaissance of the Twelfth Century,* pp. 330 f.

In giving scientific or natural reasons for alleged supernatural phenomena, in using the "Mohammedan practices" of experimentation, in delving into alchemy, and in disregarding Aristotle as an infallible authority, Bacon laid himself open to ecclesiastical censure. He was labeled with all the names in the medieval vocabulary which were applied to those deemed anti-social: Mohammedan, infidel, atheist, magician, sorcerer. He was condemned by the ecclesiastical courts and cast into prison, where he served two sentences totaling twenty-four years, being released at eighty years of age just a year or so before his death. His writings were suppressed at the time of his demise.

The great struggle for the freedom of science from ecclesiastical control was to be waged during the Renaissance period. The persecution of Roger Bacon was a forerunner of many later heresy trials. The church was ready to wage a relentless warfare against science, and science was now prepared to raise up martyrs, if need be, for its cause of freedom and truth.

CHAPTER IV

THE RENAISSANCE AND MODERN SCIENCE

WHAT history calls the Renaissance is for science the Declaration of Independence. Many influences contributed to the liberation of science in Europe in the fourteenth century, for the period known as the revival of learning, or the new birth, was an age of great scientific change as well as of artistic and literary achievement. But no era is sharply defined from the preceding era; we see the dawn of the scientific renaissance in influences already at work in the Middle Ages, and we also discover traces of medievalism carried over into the age of the Renaissance.

The Renaissance was a movement, the resultant of many influences, that profoundly transformed the medieval attitude of mind and prepared the way for what we call the modern point of view.

The medievalist was mentally bound by his subservience to absolute ecclesiastical authority. He accepted without question the interpretations handed down to him—interpretations of the Bible, the early church fathers, Aristotle, Galen and Ptolemy. Theology, "the queen of the sciences," was central in importance in the thought of the teacher in the Middle Ages. He was fettered by an inferiority complex which he could not or would not cast off. The chief aim of education, as he saw it, was to prepare through religion for the life after death. He could not think for himself for he had not been trained to do so. He did not dare to think for himself for if he did so he might be adjudged a heretic. He did not know his own mind and its possibilities. He did not appreciate the values in the world about him. He swallowed whole the superstitious tales and stories of miracles foisted upon him by the church, and his childish mind also fed upon the falsehoods of alchemy, astrology and "black magic." The ideal of otherworldliness naturally caused him to belittle the values of this world. There was a large element of fear and awe in his outlook, as evil spirits were thought to people the world, to be cast out only through the powers of saints, angels, charms and relics. The little science that the medievalist employed conformed with the orthodox theology, and had its value in throwing light on biblical verses or revealing the hand of Providence to humanity.

The modernist of the Renaissance threw off the chains of ecclesiastical authority. He questioned everything to ascertain whether it was true or false. Authorities of the past were of value only when they coincided with his critical investigation and rational conclusions. Discoveries and inventions were revealing to man the possibilities of his own mind, and he was beginning to think for himself. He was also discovering the values in the world of nature about him, learning to appreciate life here and now. The facts of this world he was gathering at first hand, casting aside stereotyped opinions and theological dogmas, and thereby lessening considerably his feeling of fear and of otherworldliness. Life was no longer a grinding and arduous probation; it was an opportunity for the complete enjoyment and happiness of humanity.

The modernist was adopting a truly scientific point of view. He was turning away from theological revelation, naïve meditation, unquestioning obedience and unreasoned faith to engage in the search for truth for its own sake. He was using the methods of the keenest criticism and analysis, finding his authority in nature, the human intellect and the fruits of continual experimentation. The later modernists of the Renaissance applied the scientific method in the field of biblical learning, scrutinizing the opinions of Aristotle, Galen, Ptolemy and the ancient classics, seeing their truth and their limitations and discovering new knowledge based on this inherited scholarship. Such discoveries struck a death blow at superstition, magic, black arts and ecclesiastical charms; but the church still clung to the medieval point of view in many realms of life.

The scientific spirit of inquiry, exploration and discovery was reborn in the age of the Renaissance. When all military Europe went a crusading the travel experiences of the knights transformed their parochial outlook into a world vision. The crusaders came to know the point of view, and to appreciate the achievements of the Mohammedans. During the Middle Ages the Arabs had revived interest in the science of antiquity, centering their studies at Cordova, Spain, but this project met with little favor in Christian ecclesiastical circles. However the crusades took the knights out of a Christian into a Mohammedan world, and thus the Oriental interest in the ancient classics and science was likewise kindled in the minds of the Christians. The failure of the crusades to achieve their military objectives was a crushing blow at the prestige and power of the papacy.

New discoveries were being made which would profoundly change the outlook of mankind. The compass assured the mariner of relative security on the high seas. The telescope opened new worlds for exploration. The desire for Oriental goods led to explorations and discoveries in Africa, India, and the New World. Gunpowder marked the end of the impregnability of the castle, the fortress and the feudal lord. Roger Bacon, in England in the thirteenth century, created consternation throughout Europe when he completely cast aside the medieval method of speculation upon the propositions of Aristotle and insisted upon going straight to nature, with the method of observation and experimentation, for research work. Thus the breakdown of feudalism, the rise of free towns and cities, the establishment of colleges and universities, and the growing consciousness of nationalism, all tended to disintegrate the power and authority of the papacy and the church. A tremendous interest in the life and activities of this world caused the attitude of other-worldliness to wane. Gradually but inevitably the authority of tradition and the might of ecclesiasticism were giving way before the authority of reason, observation and experimentation in the world of nature. The recovery of ancient learning and science served as a basis for further progress. The Renaissance began with a questioning attitude, and as the age progressed added new knowledge that finally was able to clear away the barnacles of medieval magic and superstition which clung to the science of the age.

Humanism was a powerful influence of the Renaissance in preparing the way for science and the scientific method. The scholastic theology had concerned itself with the preservation, systematization and organization of past knowledge in harmony with approved ecclesiastical belief. There was practically no extension of knowledge in scholastic education. But when the revival of learning brought the Greek and Latin classics to the attention of the scholars of Europe there was an abandonment of the preservative method of scholasticism, as these ancient writings were investigated and analyzed in the true spirit of scientific literary criticism. In the field of literature this critical spirit produced the movement of humanism, as in the field of religion it produced the Protestant Reformation, and in the field of politics the evolution of democracy.

But most powerful of all was the scientific renaissance in the narrower sense. The Inquisition was still a martyr-making force in this era, and scientists thought twice before locking horns with such a cruel institution by giving wide publicity to scientific theories that varied from the Babylonian-Hebrew science of the church. How much the Inquisition deterred science no one can tell, but it was inevitable that with the support of numerous secular influences freedom and liberty were bound to defeat coercion and suppression, even when opposed by the supreme power of a sacred institution.

Nicholas Copernicus was the pioneer in attacking the Ptolemaic system of astronomy. This Polish scientist denied that the earth was the center of the universe, with the sun, moon, and stars revolving about the earth. Holding the ancient heliocentric theory of Pythagoras rather than the geocentric theory of Ptolemy he asserted that the sun was the center of the universe and that the earth and planets revolved about the sun. He kept his revolutionary conception to himself until on his death bed he completed for publication a report of his great scientific discovery, and when the

Inquisition became aware of the book the author was beyond its summons and penalty. At the time, indeed, the church was not especially concerned about the Copernican theory, advanced only as a tentative hypothesis, and it took no drastic action. Few accepted the theory and there were no champions of science to advance it effectively. It was not until sixty years later that it attracted universal attention.

Andreas Vesalius, a young Belgian student of anatomy, bravely launched an assault upon Galen, the Roman physician, whose teachings were the basic medical authority for the Middle Ages. When but twenty-eight years of age Vesalius published an outstanding work on anatomy, setting forth the results of his many dissections of the human body. He exposed the error of Galen in assuming that the bones of human beings were identical with those of animals, Galen never having dissected a human body. Vesalius proved the vital necessity for direct observation, as against reliance upon outgrown ancient authorities.

Such a daring attack speedily called forth the ire of the church. There had been an unwritten law in church canon traditions which forbade the dissection of a human body, and a conference of the clergy, called to consider the case of Vesalius, declared such a procedure to be un-Christian. During the Middle Ages it was naïvely believed that the human body contained a bone that would serve as a nucleus for a new body at the resurrection. Another amusing belief, held in all seriousness, was that since Eve had been created from Adam's rib there was consequently one less rib in man than in woman. Vesalius discovered no resurrection bone and found that man had as many ribs as woman. He was hailed before the Inquisition upon the trumped-up charge of dissecting a living man, and would have been sentenced to death had not King Charles V of Spain, whose physician he was, intervened for him.

The Inquisition finally sentenced Vesalius to make a pilgrimage to Palestine. He fulfilled the conditions of the penalty and on his return voyage was shipwrecked and died of hunger. He was the first physician in a thousand years to advance beyond the medical horizons of Hippocrates and Galen, and was truly the father of the science of anatomy.

Giordano Bruno, an Italian Dominican friar and a bold advocate of the Copernican theory, answered his critics by asserting that the Bible taught about God and life but not about science. He strongly affirmed that the sun was the center of the universe, that the earth moved around the sun, and that there was a possibility of other inhabited worlds than ours. Bruno also vigorously attacked the standard theology, expressing doubts concerning the dogmas of the immaculate conception and transubstantiation in his work *On the One Cause and on the Infinity of the Universe and of Worlds.* Cast into prison for seven years, with every possible measure taken to force him to recant, he was finally burned at the stake in Rome and his ashes ignominiously scattered to the winds. But there was yet Galileo, who would carry on.

Tycho Brahe, Danish astronomer, after years of observation and experimentation, employing astronomical instruments of great accuracy, produced a voluminous amount of valuable data, including astronomical tables known as the Rudolphine tables, which were of great service in the establishment of the Copernican theory by later scientists. He held neither the Ptolemaic nor the Copernican theories but evolved a theory of his own, known as the Tychonic system, which was soon forgotten. According to it the planets revolve about the sun and the heavens revolve about the earth. Brahe's chief contribution was his vast amount of assembled data, which proved a gold mine to later scientists.

Galilei Galileo, a citizen of Pisa, Italy, was a thoroughgoing scientist, in the modern sense of the term. Accurate observation and experimentation were his methods of work. While worshiping in the cathedral at Pisa he noticed the swinging of a great lamp, and timing the movements by his pulse he discovered the principle of the pendulum. Assembling the faculty and student body of the University of Pisa, he established the law of falling bodies by dropping simultaneously a hundred pound and a one-pound shot from the top of the famous leaning campanile or bell tower. He later devised an improved telescope lens that would magnify fifty times. But Galileo locked horns with the Inquisition when he set forth, as truth, the Copernican theory of astronomy. In 1616 he was hailed before the Inquisition on the charge of heresy. The documents of the case are an interesting commentary on the attitude of the church toward science:

> Whereas you, Galileo . . . were denounced in 1615 to this Holy Office, for holding as true the false doctrine taught by many, namely, that the sun is immovable in the center of the world, and that the earth moves, and also with diurnal motion; also for having pupils whom you instructed in the same opinions; also for maintaining a correspondence on the same with some German

> mathematicians; also for publishing certain letters on the solar spots, in which you developed the same doctrine as truth. . . .
>
> Therefore, this holy tribunal being desirous of providing against the disorder and mischief thence proceeding and increasing to the detriment of the holy faith, by the desire of His Holiness, and of the Most Eminent Lords Cardinals of this supreme and universal Inquisition, the two propositions of the stability of the sun, and the motion of the earth, were qualified by the Theological Qualifiers as follows:
>
> The proposition that the sun is the center of the world and immovable from its place is absurd, philosophically false, and formally heretical, because it is expressly contrary to the Holy Scriptures.
>
> The proposition that the earth is not the center of the world, nor immovable, but that it moves, and also with a diurnal motion, is also absurd, philosophically false, and theologically considered, at least erroneous in faith.

Galileo was threatened with imprisonment unless he refrained from teaching and publicly approving the Copernican theory. He agreed to be silent, but all the while he continued his scientific studies in seclusion in Florence and again and again he was indiscreet enough to support publicly the Copernican theory. All the authorities of the theological world trained the guns of denunciation upon him, Catholic and Protestant alike. In 1632 Father Melchior Inchofer of the Jesuits declared: "The opinion of the earth's motion is of all heresies the most abominable, the most pernicious, the most scandalous; the immovability of the earth is thrice sacred; argument against the immortality of the soul, the existence of God, and the incarnation, should be tolerated sooner than an argument to prove that the earth moves." Luther did not lag far behind in the condemnation of the theory of Copernicus: "People gave ear to an upstart astrologer who strove to prove that the earth revolves, not the heavens or the firmament, the sun and the moon. . . . This fool wishes to reverse the entire science of astronomy; but sacred Scripture tells us that Joshua commanded the sun to stand still, and not the earth." Calvin expressed his opinion with a question: "Who will venture to place the authority of Copernicus above that of the Holy Spirit?" Even John Wesley declared that the Copernican theory tended "toward infidelity."

When Galileo published a book, in 1632, proving the truth of Copernicus and vigorously referring to the previous attempt of the Inquisition to silence him, he was hailed again before that court on the charge of heresy. Pope Urban VIII had entered the arena against Copernicus before Galileo's book appeared, and when Galileo hurt Urban's pride by riddling all his arguments, the church was further stimulated for action against the heretic. An old man, seventy years of age, without an advocate or adviser, given the third degree, threatened with torture and burning at the stake, Galileo recanted publicly, on his knees, with these words: "I, Galileo, being in my seventieth year, being a prisoner and on my knees, and before your Eminences, having before my eyes the Holy Gospel, which I touch with my hands, abjure, curse, and detest the error and the heresy of the movement of the earth." They kept him under painful surveillance until his death, eight years later. He continued his studies with lessened vigor until his eyesight failed two years before his death.

John Kepler, a German mathematician, utilizing the data assembled by Tycho, in fact having personally coöperated with him in working out the Rudolphine astronomical tables, was interested primarily in the number, size, and motion of the heavenly bodies. After spending twenty-five years in working mathematically on the assembled data he arrived at three laws governing the movements of the planets—one of the most wonderful discoveries ever made in pure science. Stated briefly the laws are as follows: (1) Planets move in ellipses; (2) a line (radius vector) drawn from the center of the sun to a planet sweeps over equal areas in equal times; (3) the squares of the periodic times of the planets are proportional to the cubes of their distances. Kepler also wrote a work on optics, and invented a telescope that was much superior to Galileo's instrument. He was an enthusiastic advocate of the Copernican theory, and since his laws proved the motion of the earth he too came into conflict with ecclesiasticism.

Kepler's works were condemned by the Roman church and placed on the Index. Even Protestants in Germany warned him "not to throw Christ's kingdom into confusion with his silly fancies," and to "bring his theory of the world into harmony with Scripture." Imprisoned for his views, Kepler agreed to accept a compromise, to the effect that law governed the heavenly bodies, which might also be interpreted as divine signs as in the case of comets. He had established the existence of great laws of motion but he did not know the cause back of them. This remained for another scientist, Newton, to discover. Throughout all his unpleasant experiences Kepler revealed a beautiful spirit: "I do think the thoughts of God."

Isaac Newton, an English mathematical scientist, is noted fundamentally for his theory or law of gravitation, which revealed the underlying causes of natural laws that had been set forth by preceding scientists. It showed that the force of gravity determines the weight of bodies, the rate at which they fall, and the path described; it explained the specific gravity of planets, the causes of tides, the reason why the earth could be a perfect globe, the causes of the precession of the equinoxes, the reason for planets moving in ellipses, and the movements of comets in parabolic curves. Newton was ecclesiastically accused of taking "from God that direct action on His works so constantly ascribed to Him in Scripture, and transferring it to material mechanism . . . substituting gravitation for Providence."

René Descartes, French mathematician and philosopher, rendered scientific methodology a great service by setting forth the mechanistic conception of nature as basic in scientific research. He pointed out that first-hand examination of the facts, rather than mere acceptance of past opinion, was necessary in the establishment of truth; that the search for truth should begin in the acknowledgment of ignorance. Such a point of view was fatal to the medieval allegiance to the authority of tradition.

Francis Bacon was the first to stress the fundamental value and importance of the new methods which the leaders in science had already for some time employed. Scientific knowledge, he insisted, must be based on experience that has been carefully tested, correlated and organized. He especially stressed the method of induction—the establishment of truth by working from facts to principles, the experimental method: "We should not, like the spiders, which draw their threads from themselves, derive our ideas merely from ourselves; nor should we, like the ants, merely collect; but we should, like the bees, collect and elaborate."

The renaissance of science was fast breaking up the worlds of antiquity and medievalism. There had been glimpses of modern science in antiquity, and there are phases of ancient and medieval science in the world to-day; no absolute classification is possible, but what we are here concerned with is the distinction between the viewpoint that is solely concerned with truth arrived at through observation, experimentation and classification, and that which finds the sources of truth partially in speculation, tradition, and magic.

The universe that the renaissance of science slowly but surely undermined may be described as follows: The earth is flat in form, the center of the universe, an immovable planet. The sun, moon and stars revolve about the earth, expressly to light and heat the earth. Eclipses and meteors are divine warnings against sin, divine signs of the approaching end of the world, or divine forecastings of coming earthquakes, famines, epidemics or wars. The universe was created by divine fiat, and completed in six literal days of twenty-four hours each, approximately four thousand years before Christ. Man was created a perfect being, with perfected moral and mental powers, but was disobedient and fell from his state of innocency and perfection. In spite of all church opposition, science was winning in its struggle to substitute for this traditional picture a world view based on facts.

Leonardo da Vinci illustrates the constructive phase of the Renaissance after the initial skepticism had faded. In his almost universal grasp of the knowledge of his age he is a counterpart of Aristotle. His creative genius in art has well nigh eclipsed his scientific prowess, for all recognize "Mona Lisa" in the Louvre and "The Last Supper" in the Refectory at Milan as Da Vinci's masterpieces, but few indeed can tell of his scientific interest and achievements.

He, first of all, understood and applied the scientific method of observation and experimentation. He suggested or foresaw the possibilities of many inventions of to-day—æroplanes, industrial engines, smelting furnaces, steam engines, machine guns, and water pumps. He invented water mills, water engines, spinning machines and planing machines. He explored the field of astronomy, holding the Pythagorean astronomical views; the field of anatomy, anticipating Harvey's discovery of the circulation of the blood; the field of geology, in the study of fossils and of erosion; and the fields of mathematics, mechanics and physics. He undermined the pseudo-science of astrology by his insistence on method. His scientific writings were not generally known, due to the fact that his method of writing made his works difficult to read. He wrote left-handed, from right to left, so that his records must be held up to a mirror to be read. He is rather a solitary star of science, with but little direct and immediate influence, although his work as a scientist is marvelous.

William Gilbert, an English physician and a specialist in mathematics, chemistry and physics, set forth the results of his observations and experiments of eighteen years in his work on *Magnetism.* He held that the earth was a giant magnet, that its rotation was due to its magnetic character, and that this applied to the universe in general. He freed the study of magnetism from its association with magic, noted and classified objects which when rubbed would attract other objects, and established the knowledge of frictional electricity as an accredited science. He is said to have been the first to use the term electricity. He also explained the behavior of the compass.

William Harvey, of London, was physician by appointment to the king and also lecturer on anatomy at a medical school. Not satisfied with Galen's statement that arteries were air-filled tubes he spent nineteen years in careful studies of the flow of blood, the arteries, the veins, and the valves of the heart. Opening an artery of an animal and binding it so that the blood would not flow past, he thus proved that the blood was flowing from the heart to the leg. He next opened a vein and found that the blood was flowing from the leg to the heart. Experimenting with an arm he achieved the same results. He studied the valves of the heart and the lungs and discovered the double circulation of the blood. When he published his discovery he lost many patients, practically none of the medical profession believed him, and for twenty-five years his thesis was debated. Harvey is in reality the founder of modern physiology.

Evangelista Torricelli, coworker with Galileo, was puzzled as to why water rose in a tube, and why it rose to just a certain height. Using a tube of mercury for experiments he discovered the phenomenon of atmospheric pressure, and thereby smashed the ancient proposition that "nature abhors a vacuum." The Toricelli mercury tube became the first barometer.

Otto von Guericke, a Prussian burgomaster, was the inventor of the air pump. Taking two hollow hemispheres of copper, fitted closely together, he pumped out the air from inside them, and it is said that eight horses, pulling at each hemisphere, were unable to overcome the outside air pressure so as to separate them. This was the famous "Magdeburg hemispheres" experiment demonstrating atmospheric pressure.

Robert Boyle, the son of an Irish earl, read about Guericke's air pump and proceeded to construct a better one. Desiring to find out how much air is compressed when increased weight is put on it he discovered the law of the compressibility of gases: that the volume of a gas is decreased in proportion as weight upon it is increased.

Marcello Malpighi, an Italian professor of medicine, was among the first to reveal by his discoveries the value of the microscope. He extended the blood circulation theory of Harvey by discovering the tiny tubes called capillaries. With his microscope he studied, for the first time, the anatomy of insects. He also was the first actually to observe the circulation of the blood; Harvey had discovered it and now Malpighi reaffirmed the discovery by sight.

Edmund Halley was the first astronomer to predict the return of a comet. When a comet appeared in 1682 Halley dug up the records and found that it had made previous appearances every seventy-six years, from which he computed that it would appear again in 1758. Sixteen years after his death his prediction was fulfilled, and the comet now bears his name.

The middle and latter part of the seventeenth century saw the organization of academies of science, composed of scientific leaders. The Royal Society of London was formed in 1662, the French Academy in 1660. In Berlin such a society was founded in 1700, and the American Philosophical Society, which was scientific in purpose, dates from 1769.

Thus far the seventeenth century holds the record as the greatest era of scientific achievement in the history of the world. The scientific method became widely known. Observation and experimentation were employed as never before. Discoveries of laws, processes and scientific instruments followed one after another, each preparing the way for added knowledge and methods of procedure. From the time of Galileo to that of Newton science kept revealing an ever larger universe. It showed the world to be law-abiding, and also to be a world of small things as wonderful in this structure as the large. The foundations laid for new sciences and the organization of scientific societies reveal a freedom unheard of but a short while before. The Inquisition punished the scientists, Protestant pulpits stormed at them, and the laity at times attacked and ridiculed them. But they won the day, and supernatural explanations had to give way to natural, with consequent theological retrenchments.

The dominant interests of the Protestant leaders in the revolt against the supreme authority of the Church of Rome were theological rather than scientific. On first thought the establishment of the principle of the right of private judgment as opposed to the judgment of an intermediary priesthood backed by an infallible institution, would appear to be an influence favorable to scientific investigation and interpretation. But it did not so turn out, for instead of an infallible church an infallible book was substituted—a book understood according to the exegesis and interpretation of Luther or Calvin or Zwingli or Knox, reverting back to St. Augustine. The change of theology on the part of Protestantism did not change the attitude of hostility toward struggling science. One of the leaders revealed the mind of the reformers when he said that if creation did not take place as described in Genesis then "all the promises of Christ fall into nothing, and all the life of our religion would be lost." Luther himself opposed the Copernican theory of world origin, and thought it wicked even to cast doubt upon the literal interpretation of the Scriptures, for in the literal text of Genesis was contained all wisdom human and divine. The flat universe was rigidly approved, and any suggestions of a right of private scientific judgment that did not harmonize with the "orthodox right of Protestant judgment" was met by strong Protestant opposition, as well as by persecution from the Roman church. A hostile theological attitude toward science was encountered in Lutheran, Calvinistic, and Anglican lands.

The Protestant leaders also stressed the idea of a devil, of demon-possession, and of witches. Idiocy, insanity and imbecility were caused by Satan. The biblical verse, "Thou shalt not suffer a witch to live," and St. Paul's reference to the bewitching of the Galatians, sufficed to prove to Luther that his convictions were correct. In the teaching of the Protestant church Christ's experience with Satan, with the woman with the seven devils, and with the demons in the swine, were elaborated and magnified.

Calvin came into direct conflict with science when he led an attack on the Spanish anatomist Miguel Servetus, who discovered the pulmonary circulation of the blood. Servetus was especially ironical in his opposition to Calvin's theological work, the *Institutes*. He was an anti-Trinitarian and published a pamphlet attacking the doctrine of the Trinity. While in Vienne, France, Servetus had developed a large practice as a physician, but when his literary nom de plume had been disclosed he was placed on trial by the Roman church and condemned to be burned. Escaping to Geneva, he was arrested and tried, with Calvin as one of the judges. Calvin had been the political dictator of Geneva for years but at this time his power was waning. The final outcome of the Servetus trial reinvigorated his political prestige. Servetus was condemned, and was burned to death on October 27, 1553. The interesting point for our present purpose is Calvin's attitude toward science. Servetus had published an edition of Ptolemy's *Geography* in which the true state of Judea was described; it was pictured as a land that was hard, barren and desolate, not a land flowing with milk and honey. Calvin used this contradiction of the Scriptures against Servetus at the trial with tremendous force. Servetus replied that he had taken the words from a previous edition of Ptolemy's work, also that the statement was one that could easily be proved. The answer was that Servetus' words "necessarily inculpated Moses and grievously outraged the Holy Ghost."

Luther, Calvin, Zwingli and Knox shared the current medieval attitude toward science. While differing in minor points of interpretation they shared the literal Hebrew-Babylonian view of the origin of the world and the superstitions about comets, eclipses and demon-possession. They did not favor Copernicus, Galileo, or any of the other scientists. Zwingli was more liberal than the other reformers but he too shared the fantasies of the age. As the years elapsed the opinions of these leaders became fixed truth for the Protestants and deviation from them was deemed heresy. Modern science owes little or nothing of its progress to the direct intent of the Reformation and its leaders, although indirectly the fact of the Reformation was one of the influences that helped science to free itself from a united ecclesiasticism and authority. The ensuing divisions made the church less powerful in fighting its futile battle with science.

> The issue of the Reformation was the acceptance by all Protestant Churches of the dogma that "the Bible is a sufficient guide for every Christian man." Tradition was rejected and the right of private interpretation assured. It was thought that the criterion of truth at length had been obtained. The authority thus imputed to the Scriptures was not restricted to matters of a purely religious or moral kind; it extended over philosophical facts, and to the interpretation of nature. . . . The Reformers would tolerate no science that was not in accordance with Genesis. Among them there were many who maintained that religion and piety could never flourish unless separated from learning and science. The fatal maxim that the Bible contained the sum and substance of all knowledge, useful or possible to man, was still strictly insisted upon. So far as science is concerned, nothing is owed to the Reformation.[1]

Founded upon basic influences in the Middle Ages and the Renaissance, modern science became a more and more powerful factor in the civilization of the world in the eighteenth century, as ecclesiastical control became weaker and public opinion more tolerant. The well-established sciences of astronomy and mathematics became more dominantly influential than ever before, while the newer sciences of geology, chemistry, botany, zoölogy and physics became more universally recognized. There was still a battle royal ahead between the forces of religion and science on the issue of evolution, with important skirmishes here and there over the application of the scientific method in biblical and theological interpretation and fundamentalist controversies and law trials. But dogmatic scientists and religionists have lost every battle sooner or later, while open-minded leaders of the Christian church and the scientific laboratory have unitedly won every major conflict.

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[1] J. W. Draper, *Conflict Between Science and Religion*, pp. 71-72.

Alchemy was given a death blow by Hermann Boerhaave, professor of medicine in the University of Leyden, Holland, when he virtually founded organic chemistry, descriptive of the chemical analysis of substances occurring in animals and plants. Modern chemistry was born through a series of discoveries: carbonic acid and latent heat by Black, the chemical affinity of many substances by Bergmann, hydrogen and the composition of water by Cavendish, oxygen by Priestly, and the properties of nitrogen by Rutherford. But chemistry was still hampered by the phlogiston theory, proposed by Becher and Stahl in the century preceding. According to this theory of combustion all bodies that would burn contained an unseen substance, phlogiston, which left the body when it was burned, being taken into the air. A body could only regain phlogiston by taking it out of the air or from another substance; it was a fire principle but not fire itself. Antoine Lavoisier was thoroughly dissatisfied with this old theory of combustion, and after eight years of research he proved that burning substances took something out of the air and did not put something into it. This something that was taken out of the atmosphere was a gas called oxygen. Lavoisier was the outstanding scientist of the age in establishing modern chemistry, proving the law of conservation—that matter, seemingly destroyed, continues in some form to exist.

Pierre Laplace, the French mathematician, suggested an hypothesis to account for the origin of the solar system. His view was that planets were thrown off by the sun out of a primordial nebula, and under a contraction produced by the force of gravity. "Our earth and planets were in the beginning formed by the condensation of gases and fluid matter." This theory became known as the "nebular hypothesis." Louis Lagrange collaborated with Laplace in making great mathematical discoveries in the realm of astronomy. In studying the perturbations or seeming irregularities in the movements of the planets he found that the solar system was stable, these irregularities occurring at regular intervals. Lagrange proved the constancy of the planetary orbits. William Herschel constructed the largest telescope of his day, forty feet long. With this improved instrument he discovered that Uranus was a planet and not a star. He classified stars into groups according to brightness, and estimated the number of stars in each area. He also noted five hundred double stars, of which but few had been previously observed. Going beyond Newton, who had discovered that gravitation acted upon the sun and planets, he proved that it influenced distant suns as well. He called the cloud mists nebulæ, believing that they were new worlds in the process of creation—star dust, forming new stars. His son, John Herschel, continuing the work of his father, made exhaustive surveys of the stars both in the northern and southern hemispheres. Using the finest of telescopes, he was the first to scan the "entire" heavens. He popularized astronomy in the best sense of the term, giving an interesting, comprehensive and understandable account of astronomic achievements from the earliest beginnings to his day. Father and son, in beginning the accurate mapping and charting of the heavens, are accredited with being the founders of modern astronomy. Thus did astronomy sever, once and for all, its affiliations with the pseudo-science of astrology.

Science turned its attention also to the earth, utilizing the results of astronomical discoveries. Abraham Werner declared that the earth revealed a wonderful history, if one would but read that story in the rocks. James Hutton developed a theory of the earth's formation, based on his studies of fossils and erosion. He held that a study of changes now operative would reveal the past history of the earth, and that the study of rocks in the process of formation to-day would reveal how rocks were formed ages ago. He thus anticipated the doctrine of uniformitarianism which Lyell developed later. Werner and Hutton were two of the founders of modern geological science. Charles Lyell explained the past changes of rocks and the surface of the earth by natural causes which are still operative and will continue to operate. Through his study of the fall of rain, the sediment carried down by rivers, minerals brought to the surface by springs, ocean tides and currents, coral growth, volcanic lava, earthquakes, and the interment of plants and animals, Lyell proved the doctrine of uniformitarianism: that "changes in the crust of our earth have been brought about in the course of long ages by causes like those which are still in action."

The outstanding work of George Buffon was the production of a natural history of animals, their earthly distribution and environmental influences. It was a splendid descriptive piece of writing but rather poorly classified and organized. Carl von Linné supplemented Buffon's work by a most careful and detailed classification and organization of the materials of natural history. Linné added to the standard name for a group of plants or animals a second, definite name for each plant or animal, this classification being termed binomial.

Albert von Haller, a professor of anatomy in Germany, discovered the power of contraction in muscles. He also studied human organs in comparison with the same organs in the lower animals, thus marking the inception of comparative anatomy, which John Hunter raised to the position of a distinct and separate science. Hunter further attempted to trace the history of the various organs of the body.

Lightning rods were invented by Benjamin Franklin, who proved that lightning was electricity by drawing it down from the storm clouds by means of a kite. Aloysius Galvani discovered animal electricity by the use of an electrical machine, brought in contact with the nerves of the legs of a dead frog. The term galvanism has been given to that branch of science which treats of currents arising from chemical action, as from the combination of minerals and acids: current electricity generated by batteries. Alessandro Volta extended Galvani's investigations, becoming the inventor of the voltaic cell. The unit of electro-motive force was called the volt, in honor of Volta. Joseph Sauveur made studies in the field of acoustics to determine a fixed note in music as a starting note. He also studied the means of counting vibrations. Ernst Chladni has been called the "father of modern acoustics," due to his penetrating research methods and results. He was especially interested in the scientific study of music, and elaborated a theory of musical sound.

Preventive medicine was instituted by Edward Jenner through his work on vaccination, which gave rise to the new science of immunology. There was a current belief in the dairy district of western England that the milk-maids who had become infected with cowpox were exempt from smallpox. Jenner developed this notion into a scientific hypothesis and experiment. On May 14, 1796, he vaccinated an eight-year-old boy with cowpox, and on July 1 inoculated him with smallpox virus, and his experiment proved to be one of the greatest victories of scientific medicine. Jenner met with the most bitter opposition from both medical and ecclesiastical circles. James Simpson, greatly distressed at the suffering of those who were undergoing operations, sought a means of producing unconsciousness without interfering with natural organic functions. Seizing upon Liebig's discovery of chloroform he first employed it on November 4, 1847, with complete success. Theologians attacked him on the ground that physical suffering and pain were necessary because of the fall of Adam, and that anæsthetics interfered with God's will. Simpson cleverly matched Scripture with Scripture, quoting Genesis 2:21: "And the Lord God caused a deep sleep to fall upon Adam, and he slept; and He took one of his ribs, and closed up the flesh instead thereof.” Simpson’s reply to violent medical opposition was most kindly: “I have recently read, with mingled sadness and surprise, the declaration of some surgeons that anæsthetics are needless luxuries, and that unendurable agony is the best of tonics.”

Louis Pasteur proved that yeast is the one and only cause of alcoholic fermentation, and that germs or microbes cause other fermentations. He believed that “it is within the power of man to rid himself of every parasitic disease.” His great contribution to bacteriology was the idea of preventing disease by the injection of a virus to make animal or man immune to the attack of the disease. His method has been greatly expanded by modern medical science in its preparation and use of vaccines, serums and antitoxins to prevent and to combat disease. Joseph Lister in utilizing Pasteur’s work introduced the scientific treatment of open wounds. Assuming that wounds became infected by germs in the air on the patient’s body or on the hands or instruments of the surgeon, he sought a substance that would be antiseptic, preventing further infection. On battlefields both asceptic surgery, infection prevention, and antiseptic surgery, infection treatment, are now universally employed. Carbolic acid, when first used, met with the usual violent medical opposition. After these new methods of surgery became somewhat generally accepted, medical authorities were divided into two schools: the aseptic and antiseptic, with the controversy lasting for some time.

In the first part of the nineteenth century John Dalton advanced the atomic theory to explain the combinations of various elements. He held that all matter is composed of atoms or infinitely small particles of various elements—hydrogen, oxygen and sodium—

which are invisible to the unaided eye and which are yet indivisible and unchangeable and may be grouped in very small clusters called molecules. The same elements were observed to exist in the far-distant heavenly bodies, when these were studied by means of the spectroscope. Rutherford in the twentieth century has advanced the theory that each atom is a system of electrons, with a positively charged electron at the center around which the negatively charged electrons revolve.

One of the greatest scientific achievements of this same nineteenth century was the formulation of the principle of the conservation of energy—that matter and energy may be changed in form, but neither can be created nor destroyed. But in these transformations some energy is dissipated in heat, as Sir William Thompson discovered in 1852. Energy, or the power, capacity, and ability to do work, is divided into two forms: potential, or stored energy, and kinetic, or released energy which is seen and active. A frozen Niagara Falls illustrates potential energy and the same water in summer kinetic energy.

Working independently upon Newton's theory of gravitation, without the aid of a telescope, Adams and Leverrier made the brilliant discovery of the new planet Neptune, both being attracted to the problem by the gravitational disturbance of the planet Uranus. Leverrier also made an analytical chart of the orbits of the planets by which their revolutions for the next several millenniums might be predicted.

The nineteenth century saw the development of the chemistry of light or spectrum analysis: the study through a prism of the decomposition of a ray of light into bands of colored light. Bunsen and Kirchhoff adapted a prism to a telescope, creating a new scientific instrument, the spectroscope. The use of this device enabled scientists to discover the chemical constituents of the heavenly bodies, revealing the presence of the same elements as those contained in the crust of the earth. In the latter part of the century the sciences of physics and chemistry replaced the study of natural philosophy; and geology, botany, zoölogy, and physiology supplanted the older study of natural history. Then there was further differentiation and hybridization, which is to say the establishing of specialized "cross-sciences."

But it was above all the discovery or rather the formulation of the theory of evolution, by Charles Darwin and Alfred R. Wallace, which startled and upset scientific and theological circles and the world at large. The idea had existed in scientific minds back in the classic days of Greece, and in the eighteenth century Buffon, Erasmus Darwin and Lamarck had suggested this theory, but it required a champion to bring it boldly to the attention of mankind.

Charles Darwin, a young English student of natural history, was appointed naturalist of the ship "The Beagle," which was shortly to set sail upon a five-year cruise around the world. While on this voyage Darwin made a comprehensive study of the biological and geological life of the lands where the ship dropped anchor, taking voluminous notes on his observations and experiments. Completing the voyage at the age of twenty-seven he spent the next twenty years in analyzing and organizing his data. While he was putting the finishing touches on his great work, in 1858, his friend Alfred R. Wallace, engaged in scientific investigations in the Malay states of the Far East, sent his hypothesis of the diversification of animal species to Darwin for his opinion. In that paper from Wallace was the substance of Darwin's theory of evolution. On July 1, 1858, Darwin submitted a paper he had written in 1844, and the article received from Wallace, to be read before the Linnæan Society. Darwin's friends were struck with the similarity of the two theories, knowing however that Darwin had years before exhaustively gone over the ground now covered by Wallace in his paper. Darwin published his final results in November, 1858, in a work entitled the *Origin of Species.* He had set out upon that world journey as a youth firmly believing that God had created each species of life as a separate and distinct creation. After he had returned from the voyage and assembled his data he came to the conclusion that all life species have been evolved through the ages of time from simple forms of life. He saw evidences of a struggle for existence in the course of which by natural selection the fittest—which did not necessarily mean the best or even the strongest—had survived.

Darwin supplemented his first work, the *Origin of Species,* with the *Descent of Man,* published in 1871, in which he stated that mankind is part and parcel of the whole process of evolution, both physically and mentally. He also elaborated the principle of natural selection:

> As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying condi-

> tions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

While scientists have modified details, in the main Darwin's theory of the origin of plants, animals and man stands. As we have seen, the idea had been entertained by the Greeks of antiquity, but it had never been substantiated by observational and experimental evidence. The points which Darwin stressed were "variation among individuals of a species, struggle for existence, survival of the fittest, and inheritance of favorable characteristics."

> The theory of organic evolution by natural selection as maintained by Darwin was naturally subjected forthwith to the severest scrutiny, and some of its details have been successfully and destructively criticized. In particular, his explanation of the mechanism of heredity appears to be untenable, as does also his theory that small but incessant variations are gradually accumulated into departures from the original, ultimately sufficient to amount to new species. The studies of Mendel and Weismann upon inheritance and of De Vries and others upon variation, have supplemented and to some extent supplanted much of Darwin's work upon those subjects. But apart from these and other readjustments of details, the Darwinian theory stands secure and at present affords the most reasonable explanation hitherto proposed of the origin of man, and other animals, and of plants; an explanation, moreover, in harmony with the general law of evolution now accepted for the

> origin of existing forms of language, literature and art; of chemical compounds, of the earth, of the solar system; and of the stars.[2]

This was a blow to the special-creation theory of Christianity, as laid down in Genesis and taught as literal scientific fact by the church. The issue was not one of ultimate causes, but rather of the method of creation, whether sudden or slow, whether yielding an immediate and complete product or continuing in a dynamic process. The dispute was not regarding the source of life, but the method of life-transmission. The church believed in a static creation, final and completed ages ago. Science held that creation while relatively complete is yet always in the making, going on to-day as well as through past ages. The fundamental considerations about life are purpose and destiny, not method and origin.

The Christian church was aroused by Darwin's conclusions as it had not been in many years. One bishop said that Darwin was attempting "to limit God's glory in creation" that the principle of natural selection was "incompatible with the Word of God" and "a dishonoring view of nature." The bishop also congratulated himself that he was not descended from a monkey. To this Huxley replied in a sentence that has become immortal: "If I had to choose, I would prefer to be a descendant of a humble monkey than of a man who employs his knowledge and his eloquence in misrepresenting those who are wearing out their lives in the search for truth." Roman Catholics and Protestants alike heaped ridicule and condemnation upon Darwin's work. Denunciations came not only from Europe but from the United States; even from far-off Australia came a book by a lord bishop in which the great scientist was condemned. Reactionary ecclesiastics in England, France, Switzerland, and Germany contributed their fuel. Pope Pius IX, in a letter, expressed his opinions very forcefully:

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[2] W. T. Sedgwick and H. W. Tyler, *A Short History of Science*, p. 396.

> A system which is repugnant at once to history, to the traditions of all peoples, to exact science, to observed facts, and even to Reason herself, would seem to need no refutation, did not alienation from God and the leaning toward materialism, due to depravity, eagerly seek a support in all this tissue of fables. . . . And, in fact, pride, after rejecting the Creator of all things and proclaiming man independent, wishing him to be his own king, his own priest, and his own God—pride goes so far as to degrade man himself to the level of the unreasoning brutes, perhaps even of lifeless matter, thus unconsciously confirming the Divine declaration: When pride cometh, then cometh shame.

Scientific evidence during the next twenty and more years gave ever-increasing support to Darwin's theory. There arose a generation that had been trained scientifically and thought in terms of evolution, and gradually the churchmen modified their contention that evolution destroyed God, the Bible and Christianity. They reinterpreted theology, reconciling and harmonizing science with religion. Then a few became champions of the new scientific views.

The Christian church in many localities is still bitterly opposed to Darwin as witnessed in the trial at Dayton, Tennessee, and the formation of fundamentalist societies with the avowed purpose to fight Darwinism and evolution. But there has arisen a generation of scientifically trained college graduates, and church leaders trained in seminaries with the scientific outlook, who are working far and wide to give the spiritual implications as well as the scientific aspects of the evolutionary theory, that religion and theology may work together.

Throughout the conflict Darwin maintained a beautiful spirit. If he had announced his theory in Italy in the time of Galileo no doubt burning at the stake would have been deemed too good for him, but as the times had grown more tolerant Darwin was not harmed. When he passed away his remains were interred in Westminster Abbey, the highest honor possible for Great Britain to accord.

Ecclesiasticism has not been the only opponent of the growth and development of science; there has been opposition also within the ranks of science itself. There is such a thing as scientific heresy, as well as theological heresy; closed minds are possible to scientists as well as theologians; there have always been "defenders of the faith" in both realms. Copernicus, Galileo, Laplace, Herschel, Newton, Harvey, Jenner, Lyell, Darwin, Pasteur, all were accorded keen opposition by men in their own field of labors. In fact so vigorous was the opposition that it has provided material for a book by R. H. Murray, revealing the intense opposition that every scientific discovery has met at the hands of hostile scientists. Sir Oliver Lodge, who writes the introduction to this book, comments on the changed attitude of scientists to-day as compared with that of the past century: "Scientists have grown more broad-minded and tolerant to-day. In the past we see the supporters of new doctrine, the detectors of unwelcome facts, coming forward apologetically, humbly presenting their credentials, and we see them immediately snuffed out or else browbeaten and ridiculed by the High Priests of Science. Surely that sort of thing cannot happen to-day." [8] When Lamarck, in his work on *Philosophie Zoologie,* adopted the theory of evolution and stated that there was but one species in nature, he met opposition from scientists by word of mouth, in addresses and in scientific books. Darwin himself, before he had investigated the subject, said Lamarck's book was "veritable rubbish." When Darwin's publication *The Origin of Species* confronted the scientists of the day there was a decided difference of opinion. In fact it is believed that Darwin could count on his two hands the number of scientists favorable to his views. Lyell, Hooker, Huxley, Haeckel and Spencer were favorable, while Louis Agassiz and Richard Owen led the violent opposition. And so the story runs from early times to the present day, although more and more scientists are adopting the true scientific attitude regarding new discoveries and fresh truth. They may thoroughly analyze new evidence before accepting it, and may in the end hold fast to the established theory; but at any rate they do not oppose new truth with rancor and hatred.

Moreover there has been opposition to science not only from theologians and from scientists but also from philosophers. Whenever a scientific theory or discovery conflicted with the current philosophy that was held to be authoritative there were always many philosophers who took up the cudgels against it. The stages in the relations of theology, philosophy, and science toward new science, have ever been conflict, compromise, and coöperation.

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[8] R. H. Murray, *Science and the Scientists in the Nineteenth Century.*

The revival of science in the age of the Renaissance led to many wonderful inventions that were fundamental in bringing to pass the industrial revolution which occurred from the middle of the eighteenth to the early part of the nineteenth centuries. The birthplace of the revolution was England, that land with navigable rivers, good harbors, natural resources of coal and iron, a colonial empire affording an opportunity for new markets for goods, and a merchant marine protected by a powerful navy. Goods that had been made by hand or by means of simple tools came to be made by complex machinery. The small workshop with a handful of workmen was enlarged into a huge factory with thousands of employees. Small scale production gave way to large scale. The distribution and sale of commodities ceased to be local and became world-wide. This industrial revolution gave rise to the groups known as capital and labor, employer and employee. Science played a large part in bringing about the age of the machine and the factory. The invention of the fly shuttle, the spinning jenny, the water frame, the power loom and the cotton gin led to vast improvements in spinning and weaving. Steam power was applied to machinery for factory production and for transportation on land and sea. The disclosure of the secret of making coke from coal improved the process of smelting. The discovery of the method of making malleable iron from pig iron resulted in better machinery for factories. Congested factory towns and cities necessitated good waterways, bridges and roads for the transportation of raw materials as well as the finished merchandise, and later good roads and canals became second in importance, industrially, when the railway was built.

The growth of science in the latter part of the nineteenth and the first decades of the twentieth centuries has been so prodigious that the era has been aptly characterized as the age of science. The reorganization and bringing up to date of the various sciences, the improvement of scientific instruments and the manifold discoveries and inventions have captivated the interest and admiration of mankind almost to the exclusion of other worthy interests. The place in our civilization of the telephone, telegraph, electric power line, fuel oil, hot-blast furnace, incandescent light, motion pictures, phonograph, radio, automobile and æroplane, suggest how powerfully and completely science has transformed the life of modern man. Steam, oil, electricity, and steel have made this age of science supremely an age of power.

The Christian church is still divided into several camps on the question of its attitude toward science. Some leaders have sought safety in medieval theological castles, living in ostrich-like seclusion. Others have taken sword and lance and with a fiery charger have in Don Quixote fashion sought to slay the dragon of science. Still others have tried to effect a humiliating and compromising truce. A small but growing minority have attempted to coöperate with science, and that attempt has been cordially received by most of the outstanding scientists. This group of leaders from the Christian church and the scientific laboratory working together, are the hope of modern civilization.

CHAPTER V

THE REDISCOVERY OF THE BIBLE

Modern science has given Christianity an intelligent understanding and appreciation of the Bible. The scientific study of language, literature and history has made the Bible of greater value, helpfulness and power to the modern mind. No longer is it conceived to be the ultimate authority in the realm of science; rather it is to-day seen as the portrayal of the birth and development of the extraordinary spiritual experience of an ancient race, revealing, incidentally, the purely transitory scientific explanations of the past. The mechanical authority of uniform evaluation has given way to the reasoned authority of graded worth. This employment of the scientific method has led to the virtual rediscovery of the Bible.

The aim of biblical science is to discover the truth regarding the origin, the nature, the purpose, the meaning, and the value of the Old and New Testaments for the spiritual needs of modern mankind. The identical methods of research are applied in exploring the Bible that were employed some years ago in analyzing and evaluating the treasures that were exhumed in Egypt, from the tomb of King Tutankhamen in the Valley of the Kings. If a manuscript of great antiquity were unearthed in the ruins of Capernaum to-morrow, the same methods of truth seeking and the discovery of values would be utilized in its study that have been and are being used in the rediscovery of the Bible.

The word criticism in scientific terminology means fair-minded, sympathetic, intelligent and constructive judgment. In popular parlance, however, the same word has degenerated to the low level of fault-finding, flaw-picking, or in other words the intention to censure and to destroy. In view of the misconception thus caused, the substitution of the word evaluation for criticism would be most happy. The scientific study and interpretation of the Bible involves two types of critical or evaluative research.

Textual evaluation, or the lower criticism, is that phase of the work of biblical science which aims to discover the original or the oldest text of the books of the Old and New Testaments. All the known texts are assembled and compared, to determine the oldest extant. The mistakes that have crept into the texts through the ages are scientifically eliminated. The recovery of the earliest possible text, when the original is lost or destroyed, is the goal in view.

The original manuscripts of both the Old and the New Testaments long ago disappeared. The oldest recovered manuscript of the Old Testament dates back to the ninth century A.D. and of the New Testament to the fourth century A.D. Since these oldest copies are but copies of other copies, many times removed, with all the copying done by hand, the possibility of errors is very obvious, and many errors indeed have been brought to light through the careful comparison of existing texts. These texts, which are very numerous, are compared with reference "to the external evidence of MSS, versions, and citations in ancient literature and intrinsic evidence of the inherent probability of one reading as compared with a rival reading, judged by such rules as that preference should be given to the more difficult reading, the shorter reading, the most characteristic reading, and the reading which accounts for the alternative readings." [1]

For the textual study of the Old Testament an understanding of Hebrew, and for the New Testament of Greek are essential if the texts other than those in English or other modern languages are to be considered. The method of textual investigation is the method of science, and is the only reliable and trustworthy method of getting back approximately to what the authors actually wrote.

When this foundation work of text recovery has been completed, the next stage is literary evaluation, or higher criticism, the aim of which is to discover such facts as who the author was and when and where he lived and wrote. The circumstances of writing are inquired into, as also the purpose of the writer, the audience for whom he writes, and the language that he employs. What special interests does the book reveal? To what type of literature does it belong? What influences from the author's past life have left their mark upon it? What appears to have been the author's position in the life of his day? Has the book perhaps had more than one author, and if so can the different strata be distinguished? In a word, what is the historical, social, political, economic, and religious situation which is mirrored in the book? Only after an exhaustive analysis of the oldest text along these lines is a true interpretative evaluation possible. In making the first intelligent and adequate study of the Old and New Testaments biblical science is rediscovering the real nature and achievements of the spiritual experience of the Hebrews.

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[1] Hastings' *Dictionary of the Bible* (One vol. ed.), p. 167.

The scientific Bible student, seeking to throw new light upon the nature and value of the Bible, freely avails himself of the seasoned conclusions of modern science in all its varied branches.

Modern astronomy, in tracing its history back to the earliest known origins, sheds light upon the purpose and scope of science in the ancient world, especially in the Babylonian, Egyptian and Hebrew world. The biblical writers shared the scientific life of their day, adapting to the purposes of religion the primitive scientific conceptions, mingling astrology with astronomy, blending fact with fancy. These ancient conceptions, which modern science has long since modified or abandoned, were the only scientific beliefs of which the biblical writers were aware. No doubt if these writers were revising their books in our time they too would bring their science up to date, seeing greater religious values in the science of to-day. If ancient scientific beliefs are of little or no value for modern life, no authority either of science or religion can restore them to their former position of prestige and power. Biblical science shares fully the attitude of modern science toward primitive astronomical beliefs, regarding them as interesting and vital steps in the growth of science but not as ultimate authority.

Modern geology treats of the ancient and modern hypotheses of the origin and age of the earth, and reveals the forces that have been at work on external form and internal structure in biblical soil. The processes of the present are seen to be the processes of the past, and geology thus links itself with astronomy in contributing to an understanding of the Hebrew records and interpretations of natural phenomena. The biblical view of the age of the earth, the method of its creation and its relationship to the universe undergo profound reinterpretations at the hands of modern biblical scientists, and the result is not loss but tremendous gain.

Modern ethnology, in treating of the races of humanity, their origin and development, reveals the characteristics of the Semites and their Hebrew representatives as related to the Babylonians and Egyptians, and affords valuable stores of information that yields a much more accurate and comprehensive understanding of the Hebrews than can be had from the Bible alone.

Modern anthropology deals with man's origin, his antiquity, his place in nature, his relationship to other animals, his physical characteristics as an organism, and the beginnings of civilization. When specifically applied to illumine the Old Testament it reveals the developmental nature of the spiritual life of the Hebrews, their gradual outgrowing of crude and barbarous characteristics and customs.

Modern archæology reconstructs the life of antiquity by bringing to light the material remains of ancient civilizations: weapons, implements, shrines, altars, monuments, tombs, graves, temples, palaces, aqueducts, fortified walls, coins, statues, bowls, pottery, lamps, cisterns, and wells. An analysis of contemporary civilizations of adjoining nations often suggests foreign influences at work beyond national borders, and also makes more clear the total progress of an age. The life story of the Hebrews becomes more and more entwined and linked with the world of antiquity as the influences that molded that race in Canaan and elsewhere are seen reflected not only upon the pages of the Bible but also in the records and relics of other peoples.

Modern psychology analyzes and interprets the mind of all times and all nations in the personal, social and racial phases of existence. One of its outstanding contributions has been the exposition of the Oriental mind, its characteristics, peculiarities and virtues. The Hebrews were Orientals, and their mental, social and spiritual experiences must be studied and appraised not primarily from an Occidental but rather from the Oriental point of view.

Modern philology scientifically traces back the languages of the world to supposed origins, exploring their development, relations and characteristics, and grouping them in families with the fundamental features of each carefully recorded. This science of language has proved of great value to biblical science, particularly as an aid in tracing connections between the biblical religions and other religions of antiquity. Improved knowledge of the languages of the Bible has of course contributed also to a better understanding of what the writers meant to say.

The study of literature, in developing a scientific technique, has revealed the unity of all literature and the stages through which it passes, as well as its nature, forms and quality. The literary remains of Egypt, Babylonia, Greece, Rome, the Hebrews and the early Christians are now examined not only separately but in their relationship to each other and to other literature and contemporary history, and the literary principles thus deduced are employed to great advantage in the further analysis and study of the biblical books. The Bible, which has ever been considered a masterpiece purely as literature, is made to relive as the classics and vernacular writings of contemporary nations and the Hebrew and Christian noncanonical books throw added light upon it.

Modern history with its scientific methods of testing truth assembles, classifies, and interprets its sources, casts the facts thus established into literary form, and so reconstructs an accurate story of an era of man's past. In the case of the history of the Babylonians, Egyptians, Romans, Greeks and Hebrews, both as independent nations and as interdependent factors in the total life of the Mediterranean world, many reconstructions of sacred as well as secular source materials have been imperative. Historians of other days, unacquainted with the historical method, did not critically evaluate the sources of myths, legends, poetry, and traditions. Not only was fact confused with fancy but the facts at hand, either to serve a purpose or because of inadequate understanding, were often misinterpreted. Scientific history is revising the interpretations of past records and with its fresh discoveries of new documents and inscriptions on stones and clay tablets is revealing the profound influences exerted by the surrounding world upon the life of the Hebrews, and also the reflex influence of the Hebrews upon other nations in its world. Naturally all the literature of ancient nations comes under the scrutiny of the historical method, and among these the Bible is studied as the history of a race. The types of source materials are classified, the treatment of the author or authors studied, and the Bible which emerges stands on its own merits as a remarkable work of history.

The comparative study of religions has also developed a scientific technique. All the great religions have been traced from their simple and primitive sources through childhood to maturity, and thanks to such studies an adequate comparison has been made possible. The rise and growth of the Hebrew religion and of Christianity are seen in new and clearer light. The simple and naïve expressions found in the Jewish-Christian source books—the Bible—reveal themselves as normal steps in the upward climb of religions toward spiritual maturity. At the same time the fact of varying levels in our Scripture as in all scriptures establishes more firmly than ever that an absolute external authority in things spiritual is not possible—that there can be only the internal authority of growing spiritual experience.

Philosophy, in treating of life as a whole and working out a body of knowledge that is basic, comprehensive, and unified, likewise contributes to a better understanding of the Bible. In interpreting nature and human values philosophers formulate a conception of the universe and of life that is based upon the best truth or knowledge that is by them attainable. Hence an understanding of the philosophy of the nations of the ancient world as compared with the religious philosophy of the Hebrews and the early Christians cannot fail to shed light upon the significance of the Bible, both those parts which are Jewish and those which are Christian in origin.

Practically every field of human knowledge has aided in disclosing the source materials that have rediscovered the Bible. Many of the biblical conceptions have been reaffirmed, remaining unaltered; others have been slightly modified, while still others have been radically changed if not abandoned. But for every change or loss there has been a corresponding gain.

Now through the coöperation of explorer, archæologist, and linguist, we are the heirs of what was formerly regarded as prehistoric times. We now see that the Old Testament is a collection of books produced comparatively late in the history of mankind; that Moses, yes even Abraham, did not belong to an extreme antiquity, but were antedated by thousands of years in which highly civilized and cultured races occupied some of the choicest portions of the eastern hemisphere. The children of Israel, whose importance is so vigorously set forth in the Old Testament, are now seen to have been but one of the smaller tribes of antiquity. They were antedated, too, by numerous peoples of a far remoter antiquity. Throughout their history the people of Israel were surrounded, influenced, and often controlled by mighty conquerors and rulers, many of whose records have been recently opened to the readers of our day. These marvelous revelations from the archives of the nations past have painted for us a new background, in fact our first background, of the Old Testament, and have shown us the relations of Israel, religiously, socially, commercially, and politically, to their powerful contemporaries. We are now in position to judge, partly, at least, in how far the people of Israel were unlike their neighbors, and in how far they possessed the same traits of character. We can also make a comparison of the religious requirements of the contem-

> porary peoples, and thereby discover wherein lies the superiority of Israel's religion.[8]

That there have been many transient conceptions in the Bible, that have passed away when the light of science fell upon them, is obvious. The world of the Bible was a flat and stationary earth, the center of the universe, around which the sun rose and set daily. This universe was created in six literal days about six thousand years ago. All species of life were created outright during those six days. The world as known to us to-day is a round and moving earth, with the sun the center of our planetary system. It was brought into being by an age-long process. The life species were developed from simple-celled ancestors of the forms that now exist. These two conceptions could not long have place together in the mind of modern man, and the result was that the transient biblical conception, having no meaning for modern life, came to be regarded merely as reflecting a stage of culture through which the Hebrews passed.

The early Hebrew conception of Jehovah, as a tribal deity, is about on a par with the character ascribed to heathen deities. That this early conception is remote from the ideas of Jehovah found in the teachings of the prophets and of Jesus is manifest to anyone who may make the comparison. The prophets and Jesus depict a deity who is holy, pure, merciful, just, and loving, the father of all spirits. In the early conceptions anger, jealousy, deceit and cruelty are attributes of deity. A tribal deity of battles commands the slaughter of men, women and children, and the heads of the babes are to be dashed on the rocks. Clearly there could be no reconciliation, and the early transient conceptions gave way before the later and more enlightened ideals.

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[8] I. M. Price, *The Monuments of the Old Testament,* pp. 18 f.

A host of fantastic and magical conceptions are revealed as current in the biblical centuries that could not possibly exist in the minds of intelligent men of to-day. Demons were believed to torment and tempt men and to cause physical and mental infirmities. A general, in order to win a battle, had the power to command the sun to become motionless. Snakes were able to walk on their tails and also had the power of speech. Bears obeyed an order to devour children who mocked a prophet. After a sevenfold march of the attacking army around a walled city the fortifications fell. A dead man was restored to life when the corpse was placed upon the bones of a prophet. An ax-head floated upon water. A prophet ascended to heaven in a chariot of fire. Protecting angels ministered to those in need. Men were preserved intact, not a hair of the head singed, after remaining a long period of time in a red-hot furnace. An army was stricken with blindness at a prophet's command. Plagues were sent and removed at the deity's will. Stars, clouds and pillars of fire were signs of the care of deity, while darkness in the heavens bespoke divine displeasure or sorrow. Demons could be transferred from human beings to animals. Having his hair cut deprived a giant strong man of his power, but upon repentance his strength was restored that he might kill his enemies. Such things are not possible according to God's laws of nature and of science as we now understand them, and they are not of value in accrediting the Bible to our age as the supreme spiritual authority. Instead of being a bulwark or even a prop they have become a menace to real religion, and must be classed with the same type of stories found in Babylonian, Assyrian, Chaldean, Persian, Egyptian or Roman literature. They belong to the age of magic, astrology, divination and exorcism.

Social conceptions that have passed from the life of civilized peoples remain on biblical pages to be accounted for. There is polytheism, the belief in many deities, accompanied by many idolatrous rites with unsavory implications. There is slavery, with all its degrading influences upon the lives of free and enslaved persons. There is the institution of polygamy, with a favorite wife, secondary wives and concubines. There is a professional group who ply a nefarious commerce; witches and their witchcraft. In the life of our time polytheism has yielded to monotheism, slavery to freedom, polygamy to monogamy, and witchcraft to psycho-analysis.

These, then, are some of the transient conceptions that are embedded in many pages of the Bible, transient in that they are not reproduced in life to-day, whether because impossible, or useless, or harmful; transient in that while there might be something of reality in the deeds of magic there has been a misconception of the phenomena or an unverified or interpolated recording. But no matter whether they happened or not, the fact remains that such events do not happen to-day, but are transient conceptions in the Bible.

The presence of these primitive, passing points of view in the Bible by no means destroys the spiritual value of that library. It contains permanent spiritual conceptions, permanent in the sense of meeting modern as well as ancient needs. A growing conception of deity, becoming more and more lofty as the centuries pass, such a conception the Bible portrays in superb fashion and bequeathes to us as an inheritance which we may share creatively. Biographies of men and women who have faced and conquered evil in themselves, their community and their nation furnish outstanding examples and powerful incentives for similar achievements in modern life. The great bases for spiritual worship, through song, prayer and ritual, are enshrined in the Bible in developing conceptions. The unfolding ethical ideals of the Hebrew prophets afford a mighty stimulus for the task which modern prophets have to face. The biblical records of a religious-minded people, developing their faith from primitive beginnings to a sublime monotheism and a lofty ethics furnish an unequaled challenge for humanity in the twentieth century. Here we meet with conceptions of life that provide consolation for the bereaved, hope for the despondent, strength for the tempted, love for the unlovely, power for the weak, moral recovery for the sinful; conceptions which enabled the Hebrew and the early Christian to live triumphantly, and which can be shared creatively by mankind to-day and in all ages. But above all the spirit of Jesus of Nazareth—his life, teachings, and influences in his own day and in later New Testament times—is unveiled in the pages of the Bible. This is far more than a mere historical record, for Jesus' way of life, as lived by him in Palestine and shared by his early followers, has become a source of inspiration and guidance for men of all climes and ages. There is the Christ of the Nazarene highway, and there is also the Christ of the Indian road and of the American boulevard.

> Bible scholarship shows us that the Bible is not all one book; its parts are not all of equal inspiration or value; it is an evolution; it represents all stages of the moral and religious progress of the Hebrew people, from polytheism to Christianity; from God, a God of vengeance and cruelty and blood, to God, a being of justice and love, a Father in Heaven; from the ethics which says, Hate and kill your enemies, to the ethics which says, Love your enemies; from Samson and his ideals of lust, cunning and physical strength, to Jesus with his ideals of purity, pity and brotherhood. Some parts are outgrown, as Jesus said. Some parts represent the child-stage of religion and ethics; other parts represent that which is somewhat more mature and complete, on to that which is highest and best in the great prophets and Jesus.[3]

The Bible can now fearlessly take its place among the great records of the spiritual life of the ages. It has been scientifically explored, and emerging from the crucible of critical investigation it stands on its own merit. It speaks with an authority which is not external and ecclesiastical but internal and personal, the authority of spiritual experience. No parts of the Bible need ever be glossed over again, or apologized for, or ignored. Every part may be readily understood and interpreted, in so far as the records are complete and have been exhaustively treated. The Bible is a library of books of religion, and this scientific rediscovery restores it to its original purpose and rightful position in the spiritual literature of the world. It reveals a spiritual way of life, achieved progressively and gloriously perfected in the life of Jesus. No longer will its religious purpose be confused with extraneous purposes, political, scientific, or otherwise. The Bible is not, and never was intended to be, the ultimate or even passing authority for all matters scientific. It is not even to be considered the ultimate authority in the realm of religious theories. Its importance lies rather in the fact that starting from a scientific investigation of its source documents the great religious conceptions of the ages may be traced and studied, small in beginnings but great in their conclusions, conclusions however that are relative, serving as foundations upon which to build, passing by the transient, and constructing only upon that which is relatively permanent.

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[3] J. T. Sunderland, *Evolution and Religion,* pp. 139 f.

The modern scientific method of approach has given the Bible a greater human appeal, a greater intellectual unity, a greater cultural value, and a greater spiritual power.

1. A GREATER HUMAN APPEAL

The Bible is now seen as a collection of profoundly human records. It is to be classified with other great collections of sacred writings and the same scientific methods of research are to be used in studying it as are employed in investigating the Vedas, the Koran, the Kojiki, or the Book of Mormon. If the Bible is greater than all other sacred libraries it is because it records the highest and noblest spiritual achievements of humanity. But local customs, passing beliefs, and the frailties of mankind appear in connection with these outstanding spiritual victories. Instead of a mechanically-dictated literary work, whose records and experiences could never be approximated in modern life, the

Bible is a human library, human not only in its origin, but also in the larger sense that the divine possibilities which the Hebrews and early Christians realized may be realized by human beings always and everywhere. The Bible is a record of the successes and failures of humanity on the quest for spiritual personality, and its message is for all who feel the challenge of that quest. The story which the rediscovered Bible tells is a story of explorations in that Kingdom of God which is within man's soul.

2. A Greater Intellectual Unity

The Bible is now regarded as a unified literary and historical record of spiritual growth, of religious progress and of moral discovery. Its supreme purpose is spiritual, not philosophical, scientific, political or æsthetic. This spiritual aim of the authors dominates all the books of the Bible, coloring and interpreting their underlying ideas about cosmic and human beginnings and other matters nonspiritual. When each book of the Bible is analyzed scientifically, and is then viewed in relation to other units in the collection, this spiritual purpose reveals an intellectual unity. All assertions that the Bible is also scientific in purpose, and is the authoritative last word in science, must be abandoned. The Bible must not be made the unintelligent champion of outgrown science when its real nature fits it to be the intelligent advocate of progressive religion. All books and chapters and verses are to be carefully evaluated with reference to their spiritual purpose and worth, and classified in the lower or higher stages of religious growth. In the view of applied modern Christianity the spiritual authority of any part or passage will depend on its ability to meet human need now. Jesus himself used the Scriptures according to the spirit, not the letter, according to the human service that might be rendered rather than merely because the records were biblical. It is in this realm of its spiritual interests that the Bible's intellectual unity must be found.

3. A Greater Cultural Value

The Bible is the greatest literary contribution which the ancient East has made to human culture, and one of the greatest of all time. For clarity of style, beauty of expression, and revelation of the range of human emotions in the varied forms of lyric and philosophic poetry, elegies, prose narratives, parables, folk-tales, hymns, biographies, letters, sermons and epics, the Bible is matchless. Its literary rôle alone, in many lands, has been of tremendous importance—mostly notably in Great Britain, where the King James version has exerted its influence upon the literary masters of generations. The outstanding works of literary art can scarcely be understood without a knowledge of the Bible, so impregnated are they with biblical allusions. Likewise the great painters and sculptors have taken biblical themes for their finest creations. But primarily for its ability to inculcate a personal appreciation of the finest masterpiece of literature in any language or nation or age, the Bible is unequaled. These cultural values already appreciated in earlier centuries, have been greatly enhanced by the scientific literary study which modern scholarship has introduced. Thanks to such study the Bible's position as the world's greatest religious classic is made the more secure.

4. A Greater Spiritual Power

The Bible is to-day of unparalleled spiritual power because it is free to express itself in the light of modern methods of truth-finding and understanding. It can never again be successfully manipulated as sectarian propaganda but is henceforth in a position to serve the ends of universal truth. No longer is the Bible to be chained in medieval monasteries, or chained in interpretation by highly speculative but unimportant theology, or chained by decrees of church councils or threats of heresy trials, exile, ostracism or death. Too often in past centuries it has been unintelligently treated by the clergy, kept out of the hands of the laity, and exploited by theologians using proof-text exegesis to support their own petty views of church government, sacraments, ordination, creeds, and human relationships. In a word the Bible, used primarily as a means to prepare for a future world, has been largely powerless to exert the sorely needed influences for making this a better world.

But now the Bible is unchained for perhaps the first time in its history. It is free to be examined and evaluated upon its own merits. It has been exposed to a merciless criticism, as well as a fair scientific analysis, and has come through triumphantly. It deserves the spiritual allegiance of mankind because of its ability to create and develop in human nature moral intelligence, religious understanding, and ethical helpfulness. It may now win its way through the internal authority of intelligent persuasion, which it gains in losing the external authority of dogmatism.

The Bible makes a more universal and powerful appeal than ever before was possible. Its transient conceptions are shorn of their former power, and its lofty permanent conceptions are seen in their true light. Emerging from the tests of scientific knowledge it stands forth as the greatest spiritual power among all the world's sacred books.

CHAPTER VI

THE REMAKING OF THEOLOGY

THEOLOGY, once called the queen of the sciences, until the recent application of the scientific method has been the most unscientific of all sciences. This science of God, presumably the intellectual expression of religion, has pursued methods of research totally unapproved by all other sciences. For ages the ideal of preservation dominated theology. A perfect, unchangeable and final revelation of truth was bequeathed the theologian as a sacred inheritance. His task consisted in correctly interpreting this predetermined heritage, improving, revising, or reaffirming the interpretations of his predecessors. In the Middle Ages came a new development in the application of logic to theology, emphasizing a priori reasoning. The purpose of the theologian was to systematize and expound the legacy of revelation with the aid of Scripture paraphrase, dialectics, and Aristotelian philosophy. Finally, in modern times, the method of scientific observation became the research tool in the formulation of an intelligent theology. In obeying the scientific spirit of the biblical injunction to "prove all things" the theologian of to-day goes forth to study all phases of human experience, especially its spiritual aspects, discovering, classifying, and interpreting the facts of human need and spiritual values. The unscientific methods of preservation and speculation are slowly but surely being supplanted by observation and experiment, and this laboratory method will make theology an empirical science, restoring her to her rightful throne as the queen of all sciences, observing and interpreting the highest of life's realities, the spiritual.

Human experience is ever changing. How greatly in contrast are the worlds of experience of the babe, the child, the teen-age youth, the young, middle-aged and elderly man! How differently is the world experienced on a given day not only by people of different ages but also by people of practically the same age! The older generation ever believes that the younger generation is going on the rocks, and the younger generation as firmly believes that the older generation is hopelessly old-fashioned and out of date. The times have changed, and they always have and always will change. All these experiences are real, have meaning and require careful interpretation. As the people of outstanding experience in past ages have led the immature, and formed and developed the common experience of humanity, so the past heritage of experience of the race, as taught and exemplified by the leaders of to-day, will lead the immature and inexperienced.

Religious experience is an aspect and phase of total human experience, and as such is also constantly changing. The faith of a race of ex-slaves, fleeing to a mountainous wilderness for security and disciplinary training, of a harried group in the catacombs under the Appian Way, of a hermit seeking isolation in desert wastes, of an army of crusading knights on their militant pilgrimage to Palestine, or of a class of college students in a modern astronomical observatory, must ever be distinctive and unique, to meet the needs, concepts, and ideals of these varied groups in the life stream of humanity. The religion of these slaves will minister to simple wilderness needs and problems, and will include the current, naïve beliefs and practices of those primitive times. The religion of the catacomb fugitives will provide strength and courage for the hour of trial and persecution. The religion of the hermit will stress isolation, contemplation and mysticism. The religion of the crusader will reflect the characteristics of the feudal age. The religion of the twentieth century college students will require an interpretation of religious experience that may readily be correlated with the purpose, the method, and the discoveries of modern science. Life is ever in the making, and since religion is a way of life and religious experience an aspect of living, these too must always be in the making, if religion is to be alive and religious experience vital.

Out of the crucible of the religious facts of human experience comes theology, the theoretical statement and intellectual expression of religion. As the world views, concepts, ideas, needs and experiences of mankind are perpetually changing, so the religion that meets those needs is ever being remade and the theology of that religion being reconstructed. Each age formulates its own theology and creed, the elaborate and summary expressions of religion, utilizing the thought forms of its own day. A vital theology has been admirably defined as

> the attempt to think over our religious inheritance in the light of present problems, so as to formulate for to-day and to transmit to the coming generation an expression of faith vitally related to our

> actual life. . . . To deal with the vital religious beliefs of living man, to appreciate and to interpret the questionings of contemporaneous thinking, and to formulate the convictions which a Christian has a right to hold in the light of actual conditions of religious thinking and living.[1]

Theology is born, grows, matures, and dies, leaving its posterity. It is ever relative, for it is symbolical, and at best is simply descriptive, never exhaustive of its theme. It is ever made, unmade, and remade.

The sciences also are forever in the making. They do not compose a complete, perfect and final body of truth, which is bequeathed to all ages as the last word. Scientific discoveries and laws are continually being revised, as observation, experimentation and verification uncover new data. The scientific knowledge of the Babylonians and the Egyptians was remade by the Greeks, the Greek learning was revised by Renaissance scientists, and the scientific data of the Age of Rebirth is being reconstructed by modern scientists. In like manner the discoveries of the future will transform the scientific principles now in vogue. The positions held by contemporary scientists, rather than those held by scientists of yesterday or of antiquity, determine the content of what for us is scientific truth. But the scientific knowledge of the present is based upon the remade scientific knowledge of the past. While many of the views of Aristotle, Galileo, Copernicus, and Newton are foundation material for modern science, others of the findings of these earlier scientists are now discarded.

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[1] G. B. Smith, *A Guide to the Study of the Christian Religion*, pp. 485 f.

> Science is even more changeable than theology. No man of science could subscribe without qualification to Galileo's beliefs, or to all his own scientific beliefs of ten years ago. In both regions of thought, additions, distinctions, and modifications have been introduced. So that now, even when the same assertion is made to-day as was made a thousand, or fifteen hundred years ago, it is made subject to limitations or expansions of meaning, which were not contemplated at the earlier epoch.[2]

If such a master scientist as Galileo is not an absolute authority for modern science, then it is natural that the primitive, childlike scientific conceptions of the Babylonians and Egyptians should no more than afford interesting data for the understanding of the early stages of science. Should theologians be interested in preserving as "gospel truth" the world view of Oriental antiquity, when scientists have long since made discoveries that have almost completely remolded the conceptions of which that world view is a part?

But the new is ever violently opposed by the majority of humanity, no matter whether it be a new social practice, a new Paris costume, a new scientific hypothesis, or a new theology. As a rule the old persists, and authority is still claimed for it in the new day and age. The new must ever struggle with the old to gain recognition, and only gradually does final approval come. The new science, the new philosophy, or the new theology is forced to contend with the old science, the old philosophy, or the old theology. Especially is this opposition to change characteristic of religion, which aims to conserve past values, as we see when in the Middle Ages an all-powerful ecclesiastical organization utilizes methods of coercion and cruelty to bolster the authority of a theology of preservation and speculation, leaving little room for hope of either a living religion or a vital theology.

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[2] A. N. Whitehead, *Science and the Modern World,* p. 262.

In the remaking of theology, for that is the eternal task of the theologian in a world of science, absolute authority and tradition must give way to the scientific method of observation, experimentation and verification, of the needs, experiences, and ideals of humanity. Whatever does not come within the experience or meet the needs of mankind of to-day must be laid aside as valueless, no matter how closely it may be bound up with traditional beliefs, organization, or practices. The scientific method must be employed to define the nature, content, and scope of religious experience in general and of Christianity in particular, the total findings to serve as a basis for developing and remaking a thoroughly dynamic theology. The spiritual experience of Jesus that may be creative in life to-day, as well as that of the prophets, saints and great souls of all time, will afford rich materials for scientific study and research. But ever the final question will be, What kind of a spiritual experience will meet the needs and problems of this age? And the analysis of spiritual experience and modern needs will be made in the light of all the conceptions and influences that affect humanity, foremost among these being the discoveries, laws and achievements of science.

> Theology, or religious knowledge, undertaking to use the empirical method in as scientific a form as possible [writes Dr. D. C. Macintosh], will in-

> clude among its presuppositions the axioms fundamental to all true science, the principles and rules of deductive and inductive logic, and the established results of the recognized sciences as far as these may be pertinent to its investigation. But theology must also include . . . the postulate of the possibility of empirical knowledge in the religious realm. This will involve several things, namely, first, a preliminary definition of the religious object, that is, God, or the Divine, sufficient to mark off from everything else the special subject matter to be investigated; second, the existence of this religious Object as thus defined, this existence being assumed either as already amply assured on the basis of previous religious experience, or else as a fundamental working hypothesis to be tested in further religious experience; third, the accessibility of this religious Object in and for cognitive religious experience, so that empirical data in the realm of religion will be available for scientific treatment; and fourth, corresponding to the principle of dependableness of nature (often called the uniformity of nature), the principle of the dependableness of the Divine Nature, or the religious Object, God.[3]

Such a working hypothesis for empirical theology has been suggested by Prof. H. N. Wieman:

> God is that in the universe which will yield maximum security and increase of human good when lives are properly adjusted to Him. . . . This proposition refers to something truly existent in the total environment with which we inter-

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[3] D. C. Macintosh, *The Reasonableness of Christianity*, pp. 233 f.

act. . . . We know that it is good beyond anything else in the universe . . . because it is that Something, however unknown, which would and which does bring human life to the largest fulfillment when proper adjustment is made to it. . . . We know it is there because all the goods of life are dependent upon making proper adjustment to conditions of environment. . . . Therefore we know our proposition about God points very definitely to something in the total environment and something which is supremely good over all else, and a matter of most vital concern to the total conduct of human living. Thus our proposition meets the first two requirements of experimentation. It points to something which is actually existent and going on in the total environment, therefore, something which can be investigated by the methods of experiment. Furthermore it states the distinguishing feature of this object by which it can be identified, namely, the most important thing in the universe for all human living. . . . The universe is constantly behaving. . . . The whole history of mankind is one infinitesimal phase of this total behavior. . . . This is some pattern of behavior, displayed by this universe, which is God because it is that upon which greatest human good depends. Now the whole welfare of man depends upon attaining a certain correlation between human behavior and the behavior of the universe, especially in respect to those phases of universal behavior which bear most critically upon human life. . . . God is that behavior of the universe which has thus nurtured human life and which continues to keep it going and growing. The

> object of religious experimentation is to discover as clearly and fully as possible this particular behavior which is going on in the universe. For this is God. . . . He is that special kind of behavior in the universe which is most beneficent to humankind. He is, therefore, that behavior in the universe which is best distinguished from all other by calling it Father.[4]

These suggestions point the way to a profound remaking of theology, a reconstruction that will create an empirical science of religion. Using the scientific method, theology will explore the facts of its subject matter, religion, and through observation and experiment will discover the great laws and principles of the spiritual life. The facts, experiences and laws of religion are just as genuine, real, and intelligible as are the facts, experiences and laws of the material world. The spiritual aspects of human experience will furnish the data for theology. The universal and age-long God-consciousness and religious experience of humanity, and the expression of Godlikeness in human relationships, will provide the facts and hypotheses for the investigation of spiritual laws. The scientists as they investigate the physical, social and spiritual realms of life, all go to experience for their source material. One's theology in the future will not be what one has inherited from authoritative revelation, nor the sum total of one's personal speculations, but rather one's experience plus the universal spiritual experience of modern humanity, wrought out through meeting outstanding human needs, and formulated in the light of the spiritual example of the prophets, apostles, and saints of other days, affording guidance and inspiration for creative living in the twentieth century.

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[4] H. N. Wieman, *The Wrestle of Religion with Truth,* pp. 59-62.

WORLD VIEW

Modern theology is accepting the complete world view of modern science as the correct physical basis for the intelligent understanding and appreciation of the spiritual aspects of life. The primitive world view of the Hebrews, and of the Christian church in past centuries, is giving way to a thoroughgoing scientific concept.

The world is millions of years old, a very ancient world, and yet very young in comparison with other bodies in the universe. In accepting this conception theology no longer postulates 4004 B.C. as the date of the origin of the earth. The world is a sphere, moving in accordance with the natural law which operates in the universe. The belief that the world is flat, stationary, and the center of the universe has been abandoned. Creation is viewed as an age-long process of development, not completed in less than a week, but continuous and still operative in the entire universe, affecting every bit of matter, energy and life. Humanity's ancestry is to be traced to an original simple form of life, and the life of humanity, though the highest form of life on the planet, is yet related to the lower forms. The world of nature is governed by universal and uniform law, consistent, certain, and orderly, there being no breaks or interventions on the part of God or of humanity. The universe is vast beyond human measurement, not small as it was once conceived to be. Thus theology accepts as basic the material world which science reveals, and proceeds to its own task of spiritual discovery and synthesis.

GOD

Modern theology, as an empirical science, in its experimental investigation of human experience endeavors to explore and evaluate the great spiritual conceptions of life. The dependence of man upon his environment and universe is obvious. He is the highest known product of the world process. He is also a social being and ever seeks fellowship with other human beings. But when human companionship fails completely to satisfy him, in hours of great sorrow and suffering, he seeks fellowship outside humanity. Also in his ideals, his hopes and his aspirations he seeks communion not only with his fellows but beyond humanity. Man seeks this adjustment to his immediate environment and to the universe that he may obtain happiness, security, welfare and appreciation. The highest elements in man, his personality and spirituality, seek personality and spirituality through mutual comradeship with the universe. The supreme concept of theology is the intellectual expression of man's experience of fellowship beyond humanity—his experience of God. It is a dynamic ever changing, progressive concept. It has been so in the past, for God has been deemed Tribal Warrior, Venerable Patriarch, Stern Judge, Supreme King, and Loving Father. It will be so in the future, as the concept of God is given varied definitions: Intelligent Will, Loving Mind, Creative Activity, Divine Presence, Coöperative Energy or Immanent Spirit. Whatever concept the theology of our time arrives at from its study of the spiritual experience of our time will naturally be harmonious, vital and consistently satisfying in the modern world of science. Scientific analysis of spiritual fellowship will set forth a tentative definition of God, His existence being assumed upon the basis of man's past spiritual experience or as a working theory for further exploration and discovery.

JESUS

Modern developmental theology, in employing the scientific method, will discover Jesus' value in the religious experience of modern man. Not what Jesus was, or what he said, or what he did, but rather what mankind can achieve spiritually through fellowship with him to-day—that will determine the scientific evaluation of Jesus for modern life. Jesus' spiritual experience can best be described suggestively by the words love, sacrifice and service. He believed supremely in those ideals, and he lived for them, taught them and died for them. Was that spiritual experiment worth while? If it was, then Jesus may share with others an experience that can be tested by scientific experimentation. But two careful distinctions must be made; first, between the Christian religion and spiritual experience, and Jesus' own personal religion and spiritual experience; and second, between the transient and transitory phases of Jesus' faith and experience, and the relatively permanent aspects. Thus influences not suggestive of Jesus' spirit in Christianity will be set aside, and also the purely current and local phases of his life, such as demonism, signs, wonders, and eschatology. But Jesus' spirit as revealed in the Golden Rule, the Beatitudes, the Lord's Prayer and the Sermon on the Mount, creatively reproduced in the light of the needs of modern life, will portray him as the great discoverer of human values and the great revealer of the nature of God—a God with whom man may have fellowship in the environment of a universe of abiding law and ceaseless growth. Jesus will be a supreme spiritual personality or a supreme personal spirituality, the greatest term that may be applied to a life in this world.

MAN

Man is the highest product and achievement in this world of creative experiment with life, and he himself in turn is the highest form of scientific experimenter with life. Sharing processes and forms that trace an ancestry to the original single-celled creature, he has ascended through all the various stages of life to his present scale of being. No matter how simple, humble and primitive his origin may be; what he is to-day and gives promise of becoming in the future faintly suggest the inherent possibilities in his makeup. He has ever tried to coöperate with and adjust himself to his environment and universe, with its forces, powers, and values, and has achieved from within and without the qualities of intelligence, personality and character. He has also made many mistakes, grievous ones, due to ignorance, pride, selfishness, covetousness and indulgence, and he has paid the penalty and also has made others share his punishment. He has groped after coöperation with the seen world, achieving the discoveries of experimental science, and has sought communion with the unseen powers, achieving the values of religion. Man is no longer considered to be the result of an initial, spontaneous, perfect creation, but rather the completion of an age-long process of growth from a form of life of extreme simplicity to the present stage of complex and progressive development. Man's past is not viewed by modern theology in terms of a fall, but rather as a perpetual ascent, accompanied by many mistakes and setbacks but in the main showing growth and progress. His efforts to build an ideal life on earth will spring from his inner spirit, coöperating with his fellowmen and with the visible forces about him and ever seeking help from the unseen. The process through which he develops and the progress which he may make are seen as conditioned by the human will.

EVIL

Whence came evil into the life of the world? It came as a survival of the animal heritage of man and as an awakening realization of higher values and ideals of life. From childish instincts and impulses man has achieved intelligence, coöperation, helpfulness and character. The savage lives on a low plane, his culture serving elemental needs and cravings of life, as he strives according to jungle law to get and to keep what he has secured. Modern man has higher desires, needs, and ideals, living according to the law of mutual helpfulness and coöperation, practically the entire life of the savage being for civilized man an evil and sinful existence. But many times the civilized man, no less than the savage, loses self-mastery, reverting to animalism, selfishness, greed, and the lust for power. The savage is not the decadent posterity of a perfect humanity; he has taken a notable step in advance of the prehistoric cave man who preceded him. In so far as man rises to his best self, is true to the light he has received, no more can be asked of him. This does not condone misery, evil, pain, and suffering in life. The scientific view of humanity's past no doubt makes man's task appear more difficult, but it also shows that task as tremendously worth while; for modern man is in duty bound to bequeath a nobler heritage to posterity than he himself received, an inheritance of moral choices, religious purposes and spiritual ideals for the remaking of human nature. There is evil that is good in the making, evil that builds character through discipline, and evil that is selfish disobedience and indulgence. As modern man grows in character what has been outgrown becomes evil to him. Instead of a fall of man there is seen a rise, with many setbacks, since man's discovery of his soul and its possibilities brought to him a consciousness of evil.

SALVATION

Salvation is the progressive achievement of completeness in spiritual living. It is ever an achievement, never an endowment; a process, not an isolated act; an attitude and manner of living, not a mechanical belief; a perpetual ascent of man in spiritual discovery. Salvation is threefold: preventive, the avoidance of missing the mark, through spiritual education and training; redemptive, the reclaiming of those who have made mistakes through ignorance, weakness or willfulness; and progressively ameliorative, the ceaseless and perpetual improvement of life. Salvation is also social as well as individual. When man in the spirit of the true scientist thinks God's thoughts after him, and lives those thoughts, he has achieved salvation.

Jesus, in his understanding of and obedience to the spiritual laws and ideals of life, made complete living, or salvation, his goal. For Jesus salvation was fundamentally preventive, as we see from his mastery of temptations in the wilderness and throughout his public ministry, by which he saved himself every day from influences that would mar his life. His spiritual power, which reclaimed man from mistakes and errors, he himself freely employed to lift humanity from vice and crime and selfishness, and he also shared that power with others. The person who was reclaimed through fellowship with Jesus made salvation a daily achievement that was both preventive and ameliorative. For Jesus salvation was the experimental means of entrance into the way of complete living. It was not a mere avoidance of punishment; it was rather a positive entrance into a life that would crowd out evil by goodness. Salvation for others was more worth while to him than physical existence, for Jesus' way of life transcended death.

IMMORTALITY

Man believes in a future life not because of logical proof but because of the assurance of religion. He observes the conservation of matter and energy, the change of form in nature which yet is not destruction, and he hopes for the conservation of that highest form of life which is the product of the struggles and achievements of spiritual experience. However much one may be consecrated to the upbuilding and service of humanity, and however certain of the reward of an earthly immortality, still, it does make a difference whether or not there be a hope that extends beyond this present life. So many of man's experiments in his efforts to achieve the highest life for others and for himself can never be completed: he makes mistakes, is thwarted, lacks time; and so it is that his life seems but a moment or two in the life of the world and the universe.

The assurance of immortality gives everlasting purpose and significance to spiritual values; gives continuity, development and progress unending; gives balm for sorrow and strengthening comfort in the presence of death. Jesus' great experiment in living cannot have been so unimportant—or the value of such a spirit as his so slight—as to warrant annihilation in the tomb. Human instinct, intuition and judgment in the moral realm impel belief in immortality. It is a spiritual hypothesis which man feels is supported by the moral facts and premises of this life. Jesus held to that hypothesis, and lived in accordance with the facts which reënforced it, and his followers share his confidence as they face the adventure into the Great Beyond.

CHAPTER VII

CHRISTIANITY AND SCIENCE

CHRISTIANITY and science are vitally interdependent in enabling mankind to achieve the highest type of a progressive civilization. Intelligent coöperation is the only possible relationship between a progressive Christianity and a dynamic science in their mutual quest for truth. There can be no conflict between Christian truth and scientific truth, since truth is ever the same in all realms of life, in all ages, in all parts of the universe. There can be no warfare between a Christian theology that applies the scientific method and a science that is motivated by the Christian spirit. There is intelligent harmony when the facts of both Christianity and science are understood, not the harmony of compromise or of allegory or of water-tight compartments but the harmony that results when the unity of truth is fully appreciated.

> Science and religion, properly understood [says Slosson], need never conflict but should always coöperate in the advancement of the human race, for each supplies what the other lacks. Science provides the means by which human toil and suffering may be alleviated and shows how human life may be lengthened and enhanced. Religion gives inspiration to the individual and an aspiration to a high ideal. Science gives eyes to religion. Religion gives a heart to science. Knowledge is power,

> but power is impotent unless set in action and dangerous if set in action by the wrong motive. Religion, unless enlightened by science, wastes its energies in vague longings or in fruitless and sometimes harmful efforts to remedy bodily or social ills. Science may discover what conduct is most conductive to human welfare in the future. But science cannot go beyond this. It can point out the best way but it cannot inspire the individual voluntarily to follow it against his personal interest. Mere knowledge cannot of itself supply the motive for self-sacrifice for others or for the future. . . . The altruistic impulse is a religious instinct. Science can supply the motive power. Religion must supply the motive.[1]

There has been, is, and always will be, a battle royal between Christianity and science when the Bible is treated as an ultimate and final authority on matters scientific, when theological dogmas of the Middle Ages are declared to be a divine revelation, and when any branch of the Christian church endeavors to sit in judgment upon the assured discoveries of science; or on the other hand, when the Bible is considered an outgrown library of superstition, when modern empirical theology is classed with medieval speculative theology, and when science oversteps its boundaries by ruling spiritual realities out of existence. It is largely because of such misconceptions that there is in some quarters a conflict, instead of coöperation, between the Christian church and the scientific laboratory, with unfortunate attitudes on both sides; churchmen believe scientists to be materialistic atheists while scientists view churchmen as naïve bigots. Such a mutual misunderstanding is both unchristian and unscientific, as well as far reaching in its injurious effects upon the development and progress of civilization.

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[1] Quoted by F. S. Harris, *Scientific Research and Human Welfare,* pp. 355 f.

But as each new science in the past has had to feel its way, develop its technique, and fight for recognition, violently opposed at every step by the older established sciences, so the science of Christianity, empirical theology, applying the scientific method in the spiritual realm, will have to make its way in fear and trembling. Some boldly assert that science sooner or later will completely supplant religion, others that science and religion must be absolutely independent in the search for truth, while still others maintain that modern science and Christianity stand in vital need of each other for their adequate development and for the progress of civilization. Noble beginnings have already been made toward wiping out conflict and establishing peace and constructive coöperation. The modern study of the Bible, the birth of an intelligent theology, the achievements in the field of religious education, and the surveys made to enable the Christian church to meet the needs of rural and urban fields, point the way to an age of increased usefulness and power for organized Christianity. But this new day will not come to complete realization until the obstacles of outworn creeds, theological dogmas, denominational sectarianism, and scientific ignorance are overcome.

> In my opinion [writes Dr. H. F. Osborn], religion and science will unite to control the future of mankind. This will be a simplified religion and a reverent science. . . . Science alone could control the future of mankind unaided, if men and

> women and children were mere machines. . . . The existence of this human spirit, which religious-minded people call the soul, is an undeniable fact alike in science and in religion, entirely apart from the theologic question of the origin of the soul and of its immortality. Religion must also control the future of mankind, a religion purified and simplified by our knowledge of nature.[2]

The outstanding progressive leaders in the fields of both science and religion are doing their utmost to remove the causes of friction and to establish cordial relations of mutual helpfulness. A group of prominent scientists, church officials, statesmen and business men have signed an illuminating statement concerning the relations of science and religion:

> We deeply regret that in recent controversies there has been a tendency to present science and religion as irreconcilable and antagonistic domains of thought, for in fact they meet distinct human needs, and in the rounding out of human life they supplement rather than displace or oppose each other. The purpose of science is to develop, without prejudice or preconception of any kind, a knowledge of the facts, the laws and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals and the aspirations of mankind. Each of these two activities represents a deep and vital function of the soul of man, and both are necessary for the life, the progress, and the happiness of the human race. It is a sublime conception

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[2] H. F. Osborn, *Evolution and Religion in Education*, pp. 177-180.

of God which is furnished by science, and one wholly consonant with the highest ideals of religion, when it represents him as revealing himself through countless ages in the development of the earth, as an abode for man and in the age-long inbreathing of life into its constituent matter, culminating in man with his spiritual nature and all his God-like powers.

What are some of the basic contributions that science and Christianity have made to the world as well as to each other? We shall look first at science.

1. Science Discovers an Immeasurable Universe

The telescope, spectroscope and mathematical formulæ have transformed the tiny world, with the flat, immovable, centralized earth, encircled by sun, moon and stars, almost touchable by the tower of Babel, into a universe of universes which the finest scientific instruments of mankind cannot completely visualize or measure. Miles have given way to light years as a standard for the measurement of its distances, a light year being the distance that light travels in a year at the rate of one hundred and eighty-six thousand miles a second. The amazing fact is brought to our notice that the light of many stars now twinkling in the heavens at night began a journey of illumination long before the Bible was written. Stars are no longer numbered by the thousand but by the million and billion. The earth, with its diameter of seven thousand and more miles, once seemed large, but the sun's diameter of eight hundred and sixty thousand miles makes that of the earth very small in comparison, and the star Betelgeuse with a diameter three hundred times that of the sun, makes the earth shrink into comparative insignificance. This immeasurable universe that science has revealed to Christianity necessitates a conception of God that is commensurate therewith. Science has discovered the handiwork of God to be more colossal and stupendous than was ever dreamed of in past ages, and it is incumbent upon Christianity to formulate the spiritual interpretation of what science has disclosed. All world views of Christianity must be expanded to keep pace with scientific discoveries.

2. Science Discovers a Universe of Great Antiquity

A study of the cooling of the earth from its original condition to the present day, of the formation of coal beds from vegetable and arboreal matter, of the petrification of forests, of volcanic activity, of the work of glaciers, and of erosion—together with the study of young, old and dead stars—has shown the antiquity of the earth to be vastly greater than was formerly supposed. We now know it to be millions of years old, though it is relatively a baby in the universe. Modern scientists have compelled the seventeenth century theologian's guess, that the exact moment of the birth of the earth was nine o'clock on October 26, 4004 B.C., to be abandoned entirely. Indeed inscriptions on Babylonian clay tablets reveal the development of a civilization a thousand years before that date. The discovery of cultural remains, of weapons and implements, has pushed back the date still further. Prehistoric human skulls have been unearthed which are believed to be at least half a million years old. Back of these records are animal remains, then geological formations, until we are lost in ages millions of years removed from ours, and the figures go beyond our comprehension of time. This almost ageless universe gives Christianity the working basis for the development and evaluation of a greater conception of Deity than was ever before possible in human history.

3. SCIENCE DISCOVERS A LAW-ABIDING UNIVERSE

Countless observations and experiments have revealed the operation of universal and continuous laws that govern the universe and all its activities. The law that to-day rules the sun, the star, the comet, the mountain, the flower, or man, is the same law that has reigned supreme in all past ages in all parts of the universe, and will in all probability control the universe in the future. But wherever there is superstition, magic and myth, there is a world of partial or total anarchy. In a world so conceived there are interventions and breaks in the natural order; there are signs and wonders. Earthquakes, volcanoes, comets, eclipses, plagues, demons, floods, military victories and dreams all played an important rôle in the naïve interpretations of the universe that were offered in earlier centuries. Science refuses to recognize disorder and anarchy in the world of the present and unreservedly extends that ban to the world of the past as well, for the reign of law which it has discovered appears to be basic in the universe for all time. This discovery presents to Christianity a difficult problem of readjustment, both as regards events in the Bible and in Christian history that have been deemed unusual, inexplicable, extraordinary, and miraculous. Belief in a God who always works through law, who never breaks His law but ever abides by it and expects His children to follow His example, must become an essential article of

Christianity, an intelligent and consistent spiritual interpretation of a law-abiding universe.

4. SCIENCE DISCOVERS A PERPETUALLY GROWING UNIVERSE

Ceaseless growth, development, activity is characteristic of a living universe. Everything in our universe is born, grows and dies. Its past is the parent of its present, and the present of its future. Suns, moons, planets, stars, comets, mountains, rivers, trees, flowers, animals, humanity, institutions—all have been born, have grown slowly into maturity and have passed on, leaving posterity to live as best it could in accordance with natural law. Biologically this age-long process of growth may be traced continuously from complex organisms back to their simple, single-celled progenitors. All life is thus related, and nothing that lives is unrelated to other living creatures. The astronomical, geological, biological, psychological, sociological and religious studies afford abundant data to substantiate this idea of unity and development as affording the best interpretation of the process of life. Christianity in its earliest days adopted the Hebrew concept of unrelated and distinct life-creation. Science offers the hypothesis of evolution, and discovers fresh data each year to verify it. Whether or not Christianity will accept the findings of science, adopting new spiritual conceptions in the light of the evolutionary hypothesis, is a matter of conjecture. If it does not accept them it will be its duty to discover a more intelligent and reasonable biological conception, unless it reverts to the support of tradition and speculation. But such a reversion to a position that is unscientific and false is unthinkable.

5. Science Discovers the Method of Observation and Experimentation

This scientific method is in itself of as great value to humanity as the achievements in the formulation of natural laws and the invention of mechanical devices which have resulted from its use; it is the most accurate, the most consistent and the most intelligible known method to be applied in the discovery and interpretation of truth not only in the field of science but in all realms of life. A problem presents itself which requires solution. The available facts relating to this problem are assembled and upon the basis of these facts the most plausible hypothesis is formulated. Proceeding upon this hypothesis the scientist observes, experiments, verifies for error, organizes and interprets the facts. If the hypothesis is substantiated the result is a discovery of truth; if it has been proved inadequate or the facts insufficient another hypothesis is set up and the testing process renewed. Facts are faced frankly, fearlessly and courageously, and truth is followed wherever it may lead. This scientific attitude of mind is one of the outstanding achievements of the human race. That this method will be applied to priestly tradition, prophetic vision and theological speculation is inevitable. Already it has changed many fundamental biblical conceptions and is undertaking profoundly to modify theological ideas. This scientific reinterpretation of Christianity requires a technique that is still in the making. Religion is by nature conservative, and it will probably be the last realm of truth to be brought into harmony with the modern world of science.

6. Science Discovers Marvelous Apparatus for Human Welfare and Service

In popular appreciation the most conspicuous scientific achievements have not been the discoveries of natural law, nor the method of observation and experimentation, but rather the innumerable practical inventions that have transformed the interests and activities of millions. The scientist himself is more concerned that his discoveries should increase knowledge than that they should yield lucrative returns, but in spite of this noble and disinterested scientific spirit and attitude the returns in terms of human convenience and happiness have been magnificent. The earth has been transformed into one great neighborhood by the invention of new means of communication and transportation: printing press, telephone, telegraph, radio, railway, street car, steamship, automobile, and æroplane. The business world of office buildings, stores and factories has been the beneficiary of many devices yielding strength, power and time-saving value: the steel frame for buildings, the elevator, the escalator, the crane, steam and gas engines, electric dynamos and motors, typewriters, adding machines, cash registers, and almost countless types of machinery for the production of goods. The home has been greatly changed by the introduction of household conveniences; the sewing machine, the vacuum cleaner, the oil furnace, washing machines for clothes and dishes, the electric toaster, iron, percolator and refrigerator. As aids to education and recreation we have the telescope, the microscope, the spectroscope, the phonograph, the radio, motion and sound pictures. Modern cities could not exist but for the scientific achievements resulting in various types of transportation, communication, building construction and factory machinery. The rural community has likewise benefited wonderfully from scientific inventions: tractors, seed drills, harvesters, reapers, silos, and many discoveries relating to soil enrichment, rotation and improvement of crops, and animal husbandry. Commerce and trade have been greatly stimulated by modern means of transportation, on sea and land and in the air, and by modern methods of food preservation. The cause, cure, and prevention of disease, through antiseptic surgery, anæsthetics, X rays, psychiatry, psychoanalysis, psychotherapy and public hygiene and sanitation, are among the greatest achievements of science. Many other gifts has science bequeathed to humanity: electric lights, photography, matches, watches, clocks, artificial teeth, eyes, arms, and limbs, and a host of other things too numerous to mention. Truly science has discovered invaluable apparatus for human welfare and service.

We turn now to the basic contributions of Christianity.

1. CHRISTIANITY DISCOVERS SPIRITUAL REALITY

Religious experience is just as real and vital as any other aspect of human experience. It belongs to a realm beyond and above the physical and material plane of existence. It is a quality of life that manifests itself in kindness, helpfulness, consideration and good will. It is the noblest expression of man's intellect, emotions and will in action. This religious experience Christianity sets forth in terms of a personal allegiance. The spirit of Jesus, as revealing his relations with God, the supreme spiritual reality, and also with mankind, is for Christians the inspiring and ennobling exemplar of religious experience. The disciples who followed Jesus during his public ministry were conscious of an experience that they did not possess before they accepted his call and life challenge. The Christian saints and martyrs and prophets of the ages have been in fellowship with an invisible reality that differentiated them from the rest of humanity. The influence of Jesus for the past nineteen hundred and more years is an outstanding spiritual fact that has had a marvelous effect upon the life of mankind. Religious experience has come to man irrespective of his wealth, position, education or talents, and is as real as are stars, suns or planets. Christianity discovers spiritual reality, its nature, content, and laws, interpreting and evaluating them so that the highest form and quality of life may be available for all humanity.

2. Christianity Discovers Motive

Science through its laws, methods and inventions has given humanity almost unlimited power. To what purpose this power shall be put science does not say. What the human motive shall be in its manipulation science cannot suggest. Shall chlorine be employed to purify the water supply of cities and so prevent typhoid epidemics, or to annihilate millions of human beings in front-line trenches? Shall æroplanes be used for the purposes of passenger, mail and merchandise transportation, or to drop bombs upon defenseless cities? Shall the automobile facilitate business and pleasure, or kill children through reckless driving, or take enemy gunmen "for a ride?" Science may prove either a blessing or a curse, according to the motives that actuate mankind.

Christianity brings to science the motive of love, translated into all phases of living. It manifests itself in reverence for one's own life, its powers and possibilities; in the treating of other human beings as sacred personalities; in the development of good will among nations and races. It is seen in the scientist's love of truth as he pursues his studies, ascertains his laws and makes his inventions; and it is made available for the welfare of humanity as his discoveries are applied. This motive of love Christianity sees as vital in the spiritual experience of humanity, and it ventures to believe that as love was dominant in the life and teachings of Jesus so the cosmic spiritual reality, God, affords humanity the strength and support of love. The more powerful science becomes the more vital it is that a constructive and beneficent motive should control its use of power.

3. Christianity Discovers Values

Christianity discovers the supreme and ultimate values of life and the universe. It discovers the valuable and the worth while in the subjective and objective life of the individual, the group and the race. It evaluates unselfishness and selfishness, love and hate, good will and ill will, honesty and dishonesty, kindness and cruelty, optimism and cynicism, thrift and waste, tolerance and bigotry, sacrifice and indulgence, generosity and stinginess, purity and impurity, courage and cowardice, sympathy and indifference. It also endeavors to fathom the greatest issues and problems of life: suffering, sorrow, death, misfortune, failure, happiness, success, pleasure, satisfaction, and a future life. It is seeking to realize the ideal of Jesus of a "more abundant life" for humanity to-day. It utilizes the best descriptions, principles, laws and discoveries of science in offering a spiritual interpretation and evaluation of life and of the universe, hence the greater the scientific discoveries of truth the greater should be the discoveries of values by Christianity.

> Men everywhere, [declares Dr. C. A. Ellwood,] not less in the future than in the past, will always have to confront their world with hope and courage and faith, and with loyalty, good will, and devotion to their fellows, if human life is to be lived together successfully. Religion, by universalizing these values, gives a fuller meaning to life, encourages hope, strengthens endurance in suffering, intensifies loyalty to ideals, prevents pessimism, despair, and degeneracy.[8]

The spiritual life of Jesus will be the outstanding value that Christianity will offer humanity to give significance to life, temporal and eternal.

4. CHRISTIANITY DISCOVERS PERSONALITY

Christianity conceives of human beings as persons, with rights and privileges, with duties and responsibilities, in constant relationship with one another and engaged in a continuous series of mutual adjustments and efforts for the enrichment of the life of all; but where there is resultant failure and defeat its view is that amends should be made to the wronged, broken relationships restored when possible, and the utmost done to avoid future mistakes and errors. It opposes the impersonal attitudes, practices and institutions which have been responsible for such crimes and vices as infanticide, foot-binding, widow-burning, alcoholism, the drug traffic, slavery, industrial strife, political chicanery, dueling, autocracy and war. It places as

[8] C. A. Ellwood, *Man's Social Destiny*, p. 190.

central in human relationships the ideal that each person should treat himself and others as sacred personalities. Christianity further projects this ideal into cosmic relationships, assuming the existence of a Supreme Personality, the cause or source of personality in the life of the world, it being inconceivable that personality could emerge from a totally impersonal environment. Thus Christianity discovers a standpoint from which an individual may progressively attain a noble quality of life, a social life in personal relationships and a cosmic life in tune with the personal forces of the universe, freely choosing to develop, not destroy personality. Jesus, who was a supreme spiritual personality and who thought of God and of men in personal terms, reflects the personality of God. The brotherhood of man and the Kingdom of God are societies of human relationships in which that quality of life, personality, is sacred and permanent.

5. CHRISTIANITY DISCOVERS IMMANENCE

The Christian conception of God of other days, which still lingers in many minds, is that of an exclusively transcendental Being, watching from afar off, occasionally intervening in the established order of nature to express His will through praise or penalty. More and more the idea of an immanent God—a deity distinct from nature but also expressing Himself in and through nature—is supplementing the idea of transcendentalism.

> As a deeper contribution to religion, science furnishes a groundwork of the divine immanence. . . . Science has resolved matter into energy and thereby shown that it is a manifestation of the

> power that is immanent in all the physical activities of the universe. . . . Religion, also, in most of its forms and especially in its highest theism, holds to the immanence of God and finds Him in all the manifestations of the world.[4]

Therefore the person and work of God are no longer limited by time or space, but are eternally creative and active in the universe of nature and in the soul of man. The laws of nature are God's laws, and God's laws are the laws of nature, no matter whether it be in the realm of the physical or the spiritual. In a universe that is intelligible, with the inevitable hazards of evil, suffering and pain, God is ever at work with His children, guiding their choices, strengthening their purposes and refining their aspirations. Perpetual achievement of character, through conquest of self and the world, is God's ideal for humanity. Thus Christianity discovers God, a Comrade cosmic yet personal, close at hand, eager to help mankind, revealing Himself through our world of matter and of spirit no longer an aloof divine Being living in a world apart.

CHRISTIANITY NEEDS SCIENCE

Christianity coöperating with science becomes open-minded, intelligent and constructive; ignoring or fighting science it degenerates into an attitude of intolerance, ignorance and destructiveness. Medieval Christianity existed in an age of myth, superstition and coercion. Thousands upon thousands died of plagues while praying in cathedrals for deliverance or recovery. If there ever was a time when Christian faith needed medical science it was in the Middle Ages. But science was powerless to help, since the dread cruelty of the Inquisition had a strangle hold upon progress. The Christianity of to-day, however, welcomes the scientific spirit, method and discoveries as aids in the building of a stronger and more effective religion. The first adequate interpretation of the Bible was made possible through the use of the scientific method. The first accurate system of Christian belief is being formulated as theology becomes an empirical science. The great gains science has made in the field of education are being applied to Christian education. The vast number of practical inventions of science are used by Christianity in carrying forward its national and world-wide program. Christianity needs science to keep it in touch with physical and material reality and the ever fresh discoveries in that realm; without such aid and stimulus it will become out of touch with reality and be relegated to a place with the dead religions of history. Christianity cannot presume to ignore any phase of life or aspect of reality and still claim the right to suggest or decree an interpretation and evaluation of complete living.

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[4] J. H. Snowden, in *An Outline of Christianity*, IV, p. 43.

SCIENCE NEEDS CHRISTIANITY

As a world partner of Christianity science arrives at its most complete expression; without Christianity it halts at a partial and fragmentary conception of life. Christianity inspires the scientist with noble motives, honest purposes, and the love of truth, that his investigations may be undertaken for the welfare and happiness of humanity. Christianity likewise evaluates the discoveries and achievements of science, to the end that they may be used only for constructive and universally helpful purposes. Science without Christianity may forge a world war, with instruments of torture and annihilation so terrible as to endanger the entire human population of the globe. It may develop a machine civilization, so mechanical and impersonal that the very life of mankind may be crippled or crushed. It may rear a materialistic conception of life, replacing hope with despair, optimism with pessimism and friendly coöperation with cutthroat competition. But science in affiliation with Christianity will gain a deeper insight into total reality, an understanding and appreciation of the spiritual aspects of life, as well as an ultimate explanation and evaluation of its own facts and discoveries. Christianity will give science what it most vitally needs, an appreciation of the supreme worth of human life. Science cannot omit the consideration of any phase of life and still be truly scientific. Science needs Christianity if it is to be of the greatest value and the highest service to mankind.

CIVILIZATION NEEDS BOTH CHRISTIANITY AND SCIENCE

A civilization without Christianity and science would speedily revert to the conditions of the Dark Ages, when in Europe the barbarians held sway. It would be even darker and more hopeless, for although in the Dark Ages science had died the growing power of Christianity faced and coped with the barbarian hordes. But while modern civilization is very largely the joint product of Christianity and science, there are so many pagan influences present as to threaten its very existence. Deprived of the support of the two great forces that produced it our civilization would soon decline to barbarian if not to savage levels. At present it is neither completely Christian nor completely scientific; paganism is present and potent in both Christian and scientific areas, as well as in other departments of our life. Militarism, alcoholism, fundamentalism, marginal speculation, political graft, vice, crime waves, the drug traffic, diplomatic intrigue, reckless driving, industrial exploitation, illiteracy, denominational sectarianism, the color line, soviet firing squads, obscene literature and amusements, selfish patriotism, autocracy, the carving of spheres of nationalistic influence, and war, are pagan features of our modern life; they represent forces that will crush and destroy unless Christianity and science unite to rebuild civilization, divesting it of these nefarious factors and inaugurating an age that will be both scientific and Christian.

Modern science has profoundly changed the Christian religion. The exclusive interest in the world to come as been modified by a deepening appreciation of the values of this world. The flat, immovable, earth-centered universe has given way to a round, movable earth, with the sun as the center not of the universe but of one of a multitude of systems which compose the universe. The traditional picture of a single act of creation has given way to the conception of a ceaseless, creative process of the ages. Man has in a sense been dethroned from his lofty position in the universe, as his origin appears to have been very humble, yet conscious of a sublime destiny here and hereafter, through struggle and discipline he has won a position at the head of all life creation by his own moral and spiritual worth. The Bible takes a supreme place in the great religious literature of the world and wins its way in the life of modern mankind by its own inherent value and not because of any external authority. Christian theology, with its creeds and doctrines, arising to meet needs in human experience for the current age, is not final for all time to come, but must be revalued and remade for each succeeding age. Christianity must eliminate all superstition, outgrown dogma, meaningless form, autocratic power, and adopt the scientific method, if it is to build a faith that is living and progressive. In the Middle Ages science existed in an age of Christianity, or rather of autocratic ecclesiasticism. To-day Christianity finds itself in an age of science. Christianity is just as uncomfortable in this age as science was in the Middle Ages. In the Age of To-morrow Christianity and science should unite upon the plane of democratic equality, helping each other to be of greater usefulness to the world.

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